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THE BRITISH FERN GAZETTE

VOLUME TEN PART ONE

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THE REDISCOVERY OF × *ASPLENOPHYLLITIS MICRODON*, WITH A REPORT ON ITS CYTOGENETICS

P. J. GIRARD* and J. D. LOVIS**

INTRODUCTION

This investigation had its origin in the discovery by one of us (P.J.G.) in September 1965 of a living wild example of the hybrid ×*Asplenophyllitis microdon* (T. Moore) Alston at Castel in Guernsey (JEE 1966, GIRARD 1968, MCCLINTOCK† 1968). Subsequently, specimen fronds and photographs of the plant were sent for determination to Clive Jermy of the British Museum (Natural History), who identified the plant as × *A. microdon*, and suggested that J.D.L. would be interested in studying the cytology of this very rare and remarkable fern. In due course, fixations were sent to Leeds, and the results obtained are described in this paper.

The importance of the rediscovery of this fern can be judged by the fact that as far as we are aware, it had not previously been seen in this century, and indeed, the most recent report known to us is for 1885, in Marquand's *Flora of Guernsey* (1901). In all, × *A. microdon* has been found on but very few occasions. It was first discovered in 1855 at St Pierre du Bois by a Miss Wilkinson, and was subsequently found again in Guernsey some two or three times during the next few years. Only one specimen is known from outside Guernsey, found by G. Wager in 1856 near Penzance.[1] We do not know of any record for this hybrid from the continent of Europe.

It proved necessary to remove the new example of × *A. microdon* for safe keeping from its natural habitat, where its existence was precarious, to P. J. Girard's garden, where it is still doing well. More recently, in August 1967, a second example of this hybrid was discovered by P.J.G., this time at St Saviour's, Guernsey. This latest plant has not yet been cytologically studied.

HABITAT OF × *ASPLENOPHYLLITIS MICRODON*

The first of the two plants was found at Les Effards, Castel, growing under elm trees in the sloping face of a roadside hedgebank which consists largely of soil, but with its lower portion supported by a dry stone wall. The site is of NNE aspect and very well shaded by elm trees on either side, in fact, one of the few surviving country avenues for which Guernsey was once famous. The appearance and aspect of the second site at St. Saviour's is very similar to the Castel locality. This lane is however, shaded by oaks, not elms. Growing in the immediate vicinity of the hybrids were plants of *Phyllitis scolopendrium*, and of both *Asplenium billotii* and *A. adiantum-nigrum*. Also present in both the Castel station and the new site at St Saviour's are three more ferns, *Dryopteris dilatata*, *D. filix-mas*, and *Polypodium interjectum*, together with several flowering plants, *Arrhenatherum elatius*, *Brachypodium sylvaticum*, *Dactylis glomerata*, *Festuca rubra*, *Hedera helix*,

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*Castel, Guernsey. **Department of Botany, University of Leeds.

†In a recent article in *Gardeners' Chronicle* [Vol. 163 (14): 11] McClintock published two photographs of what he has called *Asplenium* × *jacksonii*; they are, in fact, *A.* × *microdon*. Ed.

[1] We are grateful to Dr M. C. F. Proctor for pointing out to us the inclusion in Keble Martin & Fraser's *Flora of Devon* (1939), of a record for the North Devon coast, reported by T. Stansfield in 1862. We have not seen a specimen.

Ranunculus repens, Rubus fruticosus agg., *Rumex acetosa, Silene dioica, Smyrnium olusatrum,* and *Umbilicus rupestris.*[1] Thus in seeking for this hybrid the presence of these habitat conditions and of this plant association is a very good guide to a site worthy of careful search. The crinkled nature of the pinnae, the bold outline and the considerable size (as compared to neighbouring plants of *Asplenium adiantum-nigrum* and *A. billotii*), are of the greatest assistance in spotting this hybrid in the field.

TAXONOMY OF × *ASPLENOPHYLLITIS MICRODON*

That a hybrid between *Phyllitis scolopendrium* and a species of *Asplenium* belonging to the *billotii*——*adiantum-nigrum* group can exist was demonstrated beyond all doubt by EMMOTT (1964), who synthesised a hybrid between *Phyllitis scolopendrium* var. *americana* and *Asplenium obovatum* Viv. (a very close relative of *A. billotii*). This hybrid does show some affinity with × *Asplenophyllitis microdon.* However, the *Phyllitis* influence is more marked in this synthetic hybrid, on account of the contribution of the *Phyllitis* and *Asplenium* parents being numerically equal, in contrast to the 1:2 ratio of *Phyllitis*:*Asplenium* chromosomes present in × *A. microdon* (see below, p. 4). There is therefore little reason to doubt that × *Asplenophyllitis microdon* does in fact represent a hybrid between *Phyllitis scolopendrium* and a species of *Asplenium.* However, the presence of both *A. adiantum-nigrum* and *A. billotii* in the vicinity of the plants of × *A. microdon* means that evidence of association cannot help to indicate which species of *Asplenium* is involved. To anticipate a later section of this paper, it can also be said now that knowledge of the cytology of the hybrid does not at the present time permit an unequivocal decision to be made between *A. billotii* and *A. adiantum-nigrum* on cytological grounds. This decision must therefore be made on the basis of morphological evidence alone.

The general concensus of recent opinion, as expressed by ALSTON (1940) and McCLINTOCK (1961), is that two distinct *Asplenium* × *Phyllitis* hybrids have been found in Guernsey, × *Asplenophyllitis microdon* (T. Moore) Alston, corresponding to *Asplenium billotii*[2] × *Phyllitis scolopendrium*, and × *Asplenophyllitis jacksonii* Alston, corresponding to *A. adiantum-nigrum* × *P. scolopendrium.* Our judgement is that this opinion is indeed correct, but this conclusion requires elaboration.

Taxonomic treatment of these two hybrids in the earlier literature is rather confusing, and it is desirable that it be reviewed here, since although previous treatments are summarised by ALSTON (1940), his paper is in fact very condensed, and his conclusions are not always stated in an obvious way.

The first reference to the plant now known as × *Asplenophyllitis microdon* is by THOMAS MOORE, who in 1855 described a var. *microdon* of *Asplenium marinum.* Soon afterwards, receipt of better material made MOORE revise this judgement, and in 1857 the plant appears as *Asplenium lanceolatum* var. *microdon.* By 1860 it had become clear to Moore that in his 1857 treatment, two distinct plants had been confused together, and he now recognises not only an *A. lanceolatum* var. *microdon*, but also an *A. adiantum-nigrum* var. *microdon.* Nowhere does Moore consider the possibility of hybridity. It is not know to us when or by whom the possibility of hybrid origin first came to be considered. In 1867 LOWE treats *A. lanceolatum* var. *microdon* as a form, with again no suggestion of hybridity, but in 1877 Col. JONES says of *A. lanceolatum* var. *microdon* that this plant was "Generally accepted as a Hybrid between *Asp. lanceolatum* and *Asp. marinum*". Again it is not clear just when it was realised that there might be here an example of an intergeneric hybrid, but STANSFIELD (1920) states that "We have long[1] considered *Scolopendrium* much more likely than *Asplenium marinum* as a parent . . . of . . . *A. lanceolatum microdon*". In 1922 (STANSFIELD 1923, p. 16), he went so far as to try to test this hypothesis with an attempt to produce a hybrid between *A. billotii* and *P. scolopendrium*, but without success (STANSFIELD 1924, p. 78). That no earlier reference to the possibility of the involvement of *P. scolopendrium* appears to exist is surprising, for as ALSTON (1940), points out, in 1859 (*sic*, = 1860), MOORE had commented not only that in *A. lanceolatum* var. *microdon* (p. 73), "scattered sori may be found, which are diplazioid, scolopendrioid, . . . ", but also (p. 89), for *A. adiantum-nigrum* var. *microdon*, that the "sori are . . . very frequently scolopendrioid". Be that as it may, the varietal names used by Moore in 1860 continued to be used throughout the succeeding literature for another eighty years until in 1940 Alston created the hybrid genus × *Asplenophyllitis*. Included by Alston in this genus were four hybrids, only two of which need concern us further here, × *Asplenophyllitis microdon* (T. Moore) Alston based (by implication) on *Asplenium lanceolatum* var. *microdon* sensu stricto of Moore 1860, and × *Asplenophyllitis jacksonii* Alston, unequivocally based on *A. adiantum-nigrum* var. *microdon* T. Moore.

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[1] All determinations confirmed in the field by D. McClintock, to whom we are most grateful.

[2] *Asplenium billotii* F. W. Schultz. The earlier literature quoted in this paper consistently uses either the name *A. obovatum* Viv., or *A. lanceolatum* Huds. for this species. For our present purposes, these may be regarded as synonyms in the sense that the same plant is intended by the users of these names as that for which we are using the name *A. billotii.* For an explanation of the nomenclatural change, see MANTON & REICHSTEIN (1962).

The type specimens for these taxa are not specified by Alston in his 1940 paper. In the case of × *Asplenophyllitis microdon*, a printed 'Type Specimen' label is attached to a sheet in the Moore Herbarium at Kew under two fronds from Guernsey, 1855, legit C. Jackson.[2] These two fronds are illustrated in Alston's paper (1940, Fig. 2), as is also a frond of × *A. jacksonii* in the Moore Herbarium, but in this case the illustrated frond is *not* one of the group of fronds (ex Hort. Jackson 1859, but without locality, also in the Moore Herbarium) which bear the 'Type Specimen' label. It is not clear who attached these labels, which may antedate Alston's interest in these plants.

Study of the series of specimens of both taxa available at the British Museum and at Kew has convinced us that two distinct hybrids are indeed involved. The important distinctions were already appreciated by Moore, who, under *A. lanceolatum* var. *microdon*, wrote (1860, p. 73), "Some Devonshire plants at first referred here, prove to be analogous forms of *Asplenium adiantum-nigrum*, having deltoid fronds and elongated central sori". These characteristics are in marked contrast to those of × *Asplenophyllitis microdon*, in which the basal pair of pinnae are *never* the largest (the longest pair of pinnae may be any number from 2 to 8 in order from the base of the frond), and in which the sori are relatively both small and placed near the margin. In these respects, the distinctions between × *Asplenophyllitis microdon* and × *A. jacksonii* reflect the basic differences between *Asplenium billotii* and *A. adiantum-nigrum*, their respective putative *Asplenium* parents.

---

[1] The idea that natural hybridisation between *Phyllitis* and *Asplenium* might be possible must have altready occurred to F. W. Stansfield by about 1908, for in *Brit. Fern Gaz.* **5**: 215 (1928), with respect to another × *Asplenophyllitis* hybrid, × *A. confluens*, he refers to "the suggestion (first made by the present writer some twenty years ago to Mr Druery) that *confluens* might be a hybrid between *Scolopendrium* and *A. trichomanes*".

[2] This is a consistent choice, for with regard to *A. lanceolatum* var. *microdon* Moore writes (1860, p. 73), of Mr. C. Jackson, " . . . to whom we are indebted for specimens." Other specimens are present on the same sheet, including a damaged frond of G. Wager's 1856 find near Penzance.

As is to be expected in such spectacular hybrid combinations, each hybrid is very variable. A curious feature of the ranges of variation exhibited by the two hybrids is that at least as far as the soral character is concerned, the fronds labelled in the Moore Herbarium as type specimens are not typical, but instead represent that extreme end of the range of each hybrid which most nearly approaches the other. The two fronds of × *A. microdon* are not very alike—one is not freely soriferous, while the other, which is much more fertile, has most of its sori placed half-way between the midrib and margin of the pinnae, in virtually the same position as the sori on the type specimens of × *A. jacksonii*. As far as soral characters are concerned, these two collections are clearly distinguished only by the longer sori of the fronds of × *A. jacksonii*. However, at the other ends of their respective ranges of variation, the soral characteristics of the two hybrids are extremely distinct. Our plant from Castel represents this most extreme and distinctive form of × *A. microdon*. It is an excellent match for a magnificent series of fronds in the British Museum, originating from St Pierre du Bois, Guernsey, collected by Miss Wilkinson in 1855, which we believe represent the first discovery of this plant, quoted as such by MOORE (1860, p. 73). It also resembles very exactly a beautiful nature-print of *A. lanceolatum* var. *microdon* included by MOORE (1860, Plate LXIX). There is therefore absolutely no doubt that our plant is × *Asplenophyllitis microdon*, irrespective of whether or not this taxon is, as we believe, in fact *Asplenium billotii* × *Phyllitis scolopendrium*.

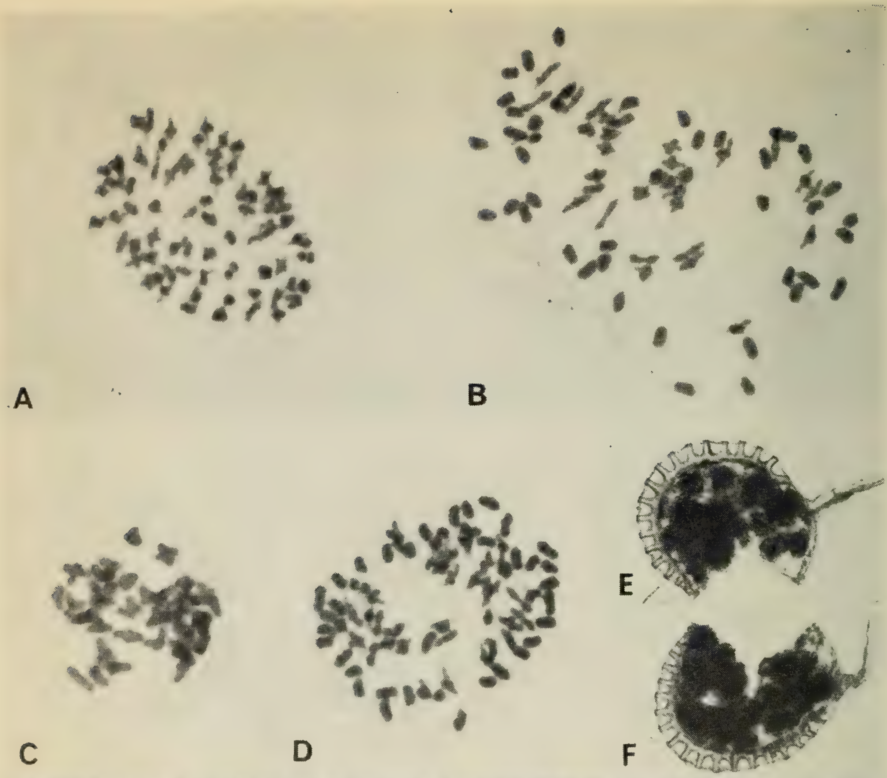
CYTOLOGY

Fixations of portions of maturing fronds of the hybrid and of examples of its presumed parent species growing at Les Effards were made in a 1:3 mixture of glacial acetic acid and absolute ethyl alcohol and conveyed by post to Leeds. Subsequently permanent preparations of meiosis in spore mother cells were made, stained in aceto-carmine.

Asplenium billotii. Clear preparations were obtained showing a regular meiosis with N = 72 bivalents (Plate IA & fig. 1). Since it is firmly established (cf. CHIARUGI 1960, FABBRI 1963, 1965) that the basic or monoploid chromosome number in *Asplenium* (apart from a small group of species centred on *A. unilaterale*), is 36, this result means that our sample of *A. billotii* is tetraploid, a finding consistent with previous investigations of this species (MANTON 1950, MEYER 1961, MANTON & REICHSTEIN 1962).

Phyllitis scolopendrium. The preparations obtained are not good, but show (Plate IC & fig. 4), a regular meiosis, with N = ca. 36 bivalents. This count is consistent with earlier determinations (MANTON 1950, VAZART 1956, MEYER 1958, EMMOTT 1964), on European material of this species, which appears to be uniformly diploid in Europe, although *P. scolopendrium* has been found to be tetraploid in North America (BRITTON 1953, EMMOTT 1964), and Japan (EMMOTT 1964, MITUI 1965, personal communication in FABBRI 1965).

× **Asplenophyllitis microdon.** Clear preparations have been obtained (Plates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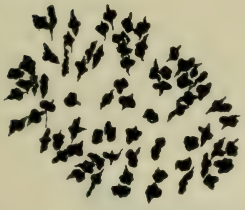

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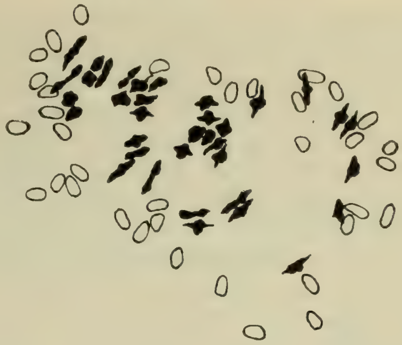

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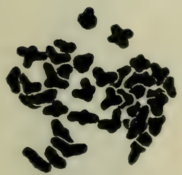

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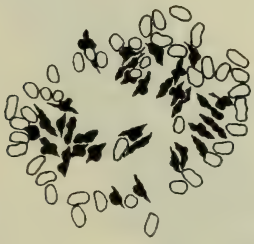


3

FIGURES 1–4: explanatory diagrams to cells illustrated on Plate 1. Bivalents in solid black, univalents in outline; magnification × 1000. Fig. 1: *Asplenium billotii.* Figs 2 & 3: × *Asplenophyllitis microdon.* Fig. 4: *Phyllitis scolopendrium.*

IB, ID, & figs 2, 3), showing an irregular meiosis, with a rather variable number of bivalents, 32–36, accompanied by 44–36 univalents. The chromosome number is 108, in other words, triploid. The cytology thus clearly confirms that this plant is a hybrid.

An interesting and informative feature of the meiotic figures in × *A. microdon* is that the bivalents are small in size in comparison with the univalents. Ever since the pioneer study of MANTON (1950, cf. Figs 95A, 95B & 123E), it has been known that the chromosomes in various species of *Asplenium* are appreciably smaller than those of *Phyllitis* spp. This difference is clearly seen in Fig. 1A & 1C accompanying the present paper. The evident conclusion from these facts is that in × *A. microdon* the bivalents present are small in relation to the size of the univalents because the bivalents are formed by pairing between the two sets of chromosomes contributed by the *Asplenium* parent, whilst the larger *Phyllitis* chromosomes are left unpaired.

It was stated earlier (p. 2), that the conclusion that *Asplenium billotii* is the *Asplenium* parent of × *Asplenophyllitis microdon* has to be based on the evidence of morphology alone. The demonstration of triploidy in × *A. microdon* does

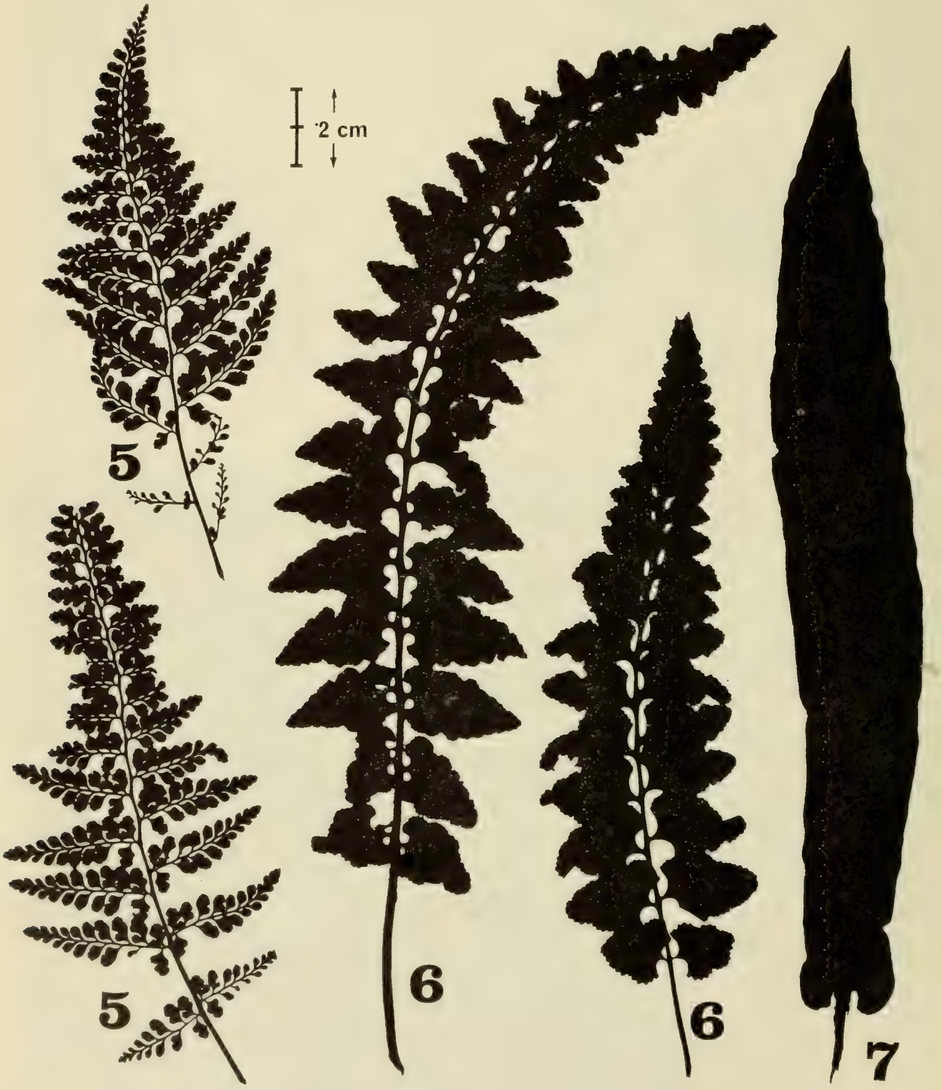
---

EXPLANATION OF PLATE I

Permanent acetocarmine preparations of meiosis; A, B, D, first metaphase; C, diakinesis. Magnification × 1000; all from Castel, Guernsey. **A:** *Asplenium billotii*, showing 72 bivalents. **B:** × *Asplenophyllitis microdon*, showing 36 bivalents and 36 univalents. **C:** *Phyllitis scolopendrium*, showing ca. 36 bivalents. **D:** × *A. microdon*, showing 34 bivalents and 40 univalents. **E & F:** glycerine jelly mounts of sporangia of × *A. microdon* from Castel, Guernsey, both showing abortive contents; magnification × 100. **G:** × *Asplenophyllitis microdon* in situ at Les Effords, Castel, Guernsey; photo: Carel Toms.

not materially assist in resolving the problem of the identity of the *Asplenium* parent of this hybrid because *A. adiantum-nigrum* and *A. billotii* are both tetraploid species. However, in the light of what is already known, through the efforts of Dr Molly Walker and Dr Anne Sleep, regarding the origins of *A. adiantum-nigrum* and *A. billotii*, the occurrence of a high degree of pairing between the chromosome sets contributed to × *Asplenophyllitis microdon* by its *Asplenium* parent does make it very much more probable that it is *A. billotii* which is involved.

Thus, although there is as yet no *direct* evidence that the two chromosome sets present in the reduced complement of *Asplenium adiantum-nigrum* are unable to



FIGURES 5–7: Silhouettes of fertile fronds from Castel, Guernsey. Fig. 5: *Asplenium billottii* Fig. 6: × *Asplenophyllitis microdon*. Fig. 7: *Phyllitis scolopendrium*.

pair together, there are nevertheless extremely strong grounds for believing that *A. adiantum-nigrum* is a classical allopolyploid (M. G. Walker, née SHIVAS, 1956, unpublished thesis), in which case the hybrid *A. adiantum-nigrum* × *P. scolopendrium* would be expected to show complete failure of chromosome pairing. In contrast, the results already obtained by SLEEP (1966, unpublished thesis), in synthetic hybrids involving *A. billotii* as one parent have clearly indicated that *A. billotii* cannot be of orthodox allopolyploid origin, since its cytological behaviour in these hybrids is like that expected of an autopolyploid. If our conclusion that the hybrid we have studied is *A. billotii* × *P. scolopendrium* is correct, then in view of the marked difference in size between the chromosomes of these two species, the meiotic pairing in our hybrid can be regarded as providing very convincing confirmatory evidence of Sleep's conclusion regarding the nature of *A. billotii*. It is important to point out that the apparent contradiction between these findings and the conclusion of SHIVAS (1956, unpublished thesis, quoted by MANTON 1961, p. 117, and MANTON & REICHSTEIN 1962, p. 87), that *A. billotii* is a classical allopolyploid, can be resolved because the correct identity of *A. billotii* F. W. Schultz has been clarified since her work was executed, and it now seems probable that whatever may prove to be the true identity of the tetraploid plant studied by her, it is not attributable to *A. billotii*, as this name is now interpreted.

It remains only to observe that attempts are now being made to resynthesise × *Asplenophyllitis microdon* and × *A. jacksonii* from their putative parents. If these hybridisation experiments are successful, they will resolve many of the questions left only partially answered by this investigation.

DISTINCTIONS BETWEEN *ASPLENOPHYLLITIS MICRODON* AND *A. JACKSONII*

	A. microdon	**A. jacksonii**
Shape of frond	lanceolate, contracted towards base	deltoid
Position of largest pinna	from 2nd–8th in order from base of frond, most often 3rd or 4th never 1st	nearly always 1st, sometimes 2nd
Length of sori	most often 2–3 mm, but frequently less, exceptional sori attain 4 mm	generally 4–6 mm, smaller only towards tips of frond and pinnae
Position of sori	usually confined to outer half of lamina, near to pinna margin, but sometimes midway between midrib and margin	usually confined to inner half of lamina, with inner part of sorus often pressed close against midrib, but sori sometimes situated midway between midrib and margin

ACKNOWLEDGEMENTS

We wish to thank Dr Molly Walker and Dr Anne Sleep for their kind permission to quote their unpublished work. We also thank A. C. Jermy for his assistance in getting our joint investigation under way.

SUMMARY

The rediscovery in Guernsey of the exceedingly rare intergeneric fern hybrid, × *Asplenophyllitis microdon* (T. Moore) Alston is described. The typification of this hybrid and the related × *A. jacksonii* Alston is reviewed. On the basis of a morphological comparison of these two hybrid taxa, it is concluded, in agreement with ALSTON (1940), that: 1, these two hybrids are truly distinct; 2, the parentage of × *A. microdon* is *Asplenium billotii* × *Phyllitis scolopendrium*; and 3, the parentage of × *A. jacksonii* is *A. adiantum-nigrum* × *P. scolopendrium*. Cytological study of meiosis in × *A. microdon* from Castel indicates that this hybrid is triploid. The pattern of chromosome pairing found suggest that *A. billotii* cannot be an orthodox allopolyploid.

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TWO NEW HYBRIDS INVOLVING *DRYOPTERIS AEMULA*

A. C. JERMY*

The plant we now call *Dryopteris aemula* (Aiton) O. Kuntze was first described by RAY in his *Synopsis Methodica Stirpium Britannicarum* (1690) p. 27 from the Glyders, Caernarvonshire; material was also figured by PLUKENET in his Almagestum Botanicum (1696). The later and relatively uneventful history of the species is adequately dealt with by NEWMAN (1854). In the British Isles it has a predominantly oceanic distribution from the Outer Hebrides to Dorset in the west appearing again in some abundance in the Weald and sparingly in NE Yorks, Durham and N Northumberland on the E coast; it is frequent throughout Ireland but commonest in the SW. In Europe the species is confined to W France, NW Spain and the Açores and is found also in the Canaries and Madeira and according to Newman (*l.c.*) in the Cape Verde Isles.

The only recorded chromosome count for *D. aemula* is in MANTON (1950) giving it as n = 41; it appeared not to be an ancestral parent of tetraploid species of the genus (MANTON 1950; WALKER 1955, 1961). Walker (pers. comm.) attempted to produce artificial hybrids between *D. aemula* and the *D. dilatata/spinulosa* complex but failed. It is therefore with some trepidation that I describe two hybrids involving *D. aemula* without cytological investigation but it was considered expedient to publish this note to stimulate further searching in the field.

DRYOPTERIS AEMULA × *DILATATA* agg.

In 1963 a plant was sent in by F. Jackson who collected it close-by his home in Borrowdale and transplanted an offset in his garden. Jackson thought that it could not be *D. dilatata* but was at a loss to give it a name. Under the light microscope the spores had the appearance of *D. assimilis* S. Walker rather than *D. dilatata*. As that species had not, at that time, been found in the Lake District spores were further studied with the scanning electron microscope as part of another project (CRABBE, JERMY & WALKER, in preparation). The spores differed from those of *D. assimilis* as follows: (i) there was greater variation both in size and sculpturing; (ii) the density of spinules on the perispore was less—they were often very scanty; (iii) the spores were more rugose; and (iv) the fine texture of the perispore was similar to that of *D. aemula* rather than *D. assimilis* [cf. Plate IIb, d, h]. Many sporangia had aborted and those that were full usually had only 32 spores and much perisporal detritus suggestive of a hybrid and the frond was re-examined with this possibility in mind. On morphological grounds this plant is indeed intermediate between *D. aemula* and *D. dilatata* or *D. assimilis*.

A description of the plant is given below (and see Fig. 1). It should be added that the presence of a diploid (*D. assimilis*) in Borrowdale has now been confirmed by Dr Stanley Walker and the possibility of that species being one parent cannot be overlooked.

Plant with erect rhizome. Fronds up to 40 cm long, ovate-deltate, gradually tapered at apex; stipe 12–15 cm, purplish at base and remaining so on drying, sparsely covered with narrow, triangular scales with darker centres; lamina mid-green, flat, smelling of cumarin. Indusia glandular at edges; sori with many abortive sporangia. Spores rugulose on drying with scattered spinnules [see Plate IIc, d].

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*British Museum (Natural History), London, S.W.7

In the Moore herbarium at Kew two sheets labelled *Lastrea dilatata* var. *Clarkei* Moore [Oban, Donolly wood, in several places, *D. Clark No. 28*; Bute 1869 Miss *E. Liddell*] fit the above description. Other specimens seen recently that would repay further investigation are: Corley's collections from Squr an Ulaidh and Ormaig woods near Oban, Argyll; plants collected by A. G. Kenneth at Erine, Kintyre and by C. A. Sinker in a glen south of the harbour, Soay, both in Herb. BM.

DRYOPTERIS AEMULA × *ABBREVIATA*

In September, 1967 when on fieldwork in connection with the British Museum (Natural History) Isle of Mull Survey, Mr Alan Eddy drew my attention to an unusual *Dryopteris* growing on steep mossy slopes of An Coire, a birch-oak wood on the SW shore of Loch Don. There was a single clone 60 cm across, a vigorous plant coming from a well-branched rootstock. Frequent over the hillside were

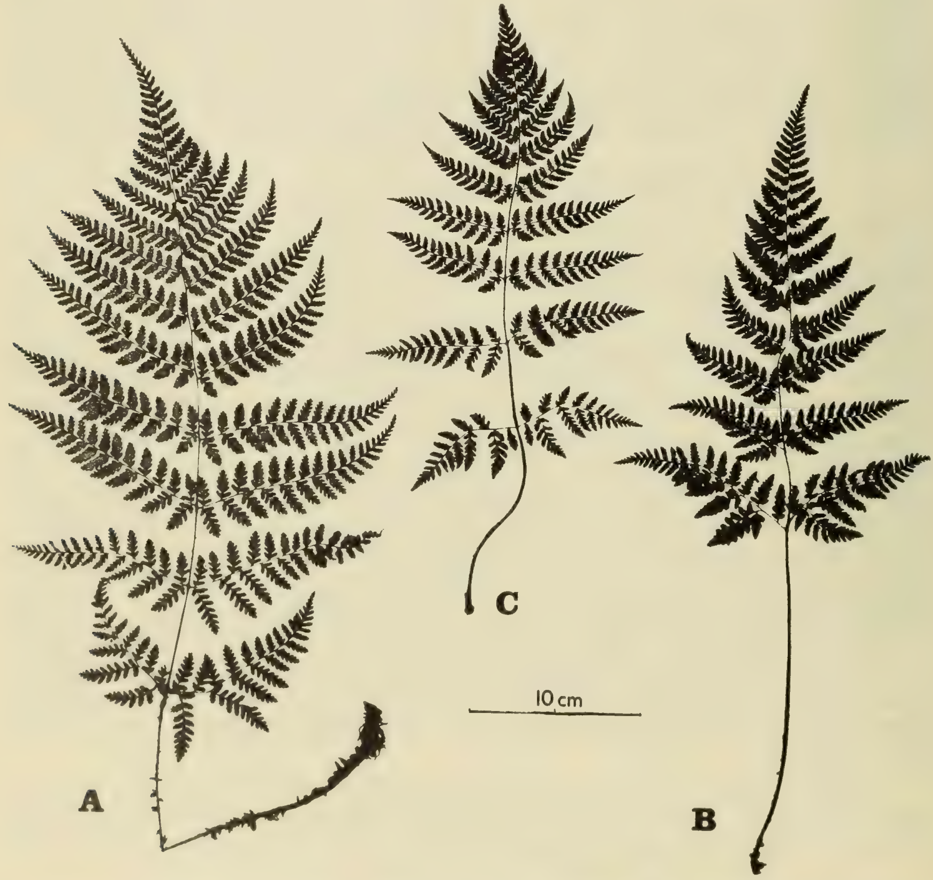

FIGURE 1: Silhouettes of *Dryopteris* fronds. **A**: *D. dilatata*; **B**: *D. aemula*; **C**: possible hybrid

D. abbreviata, *D. borreri* and possible hybrids of these taxa, and *D. aemula*. Eddy's find was fertile, each sporangium having spores of mixed sizes up to 60 μ in diam. with considerable small spore-like masses of sporopollenin; these spores have germinated and suggest so far an apogamous species. On morphological characters the plant is intermediate between *D. aemula* and *D. abbreviata* and on these grounds I describe it as a hybrid between these taxa. A thorough cytological investigation is needed of all the plants in this population. The *D. borreri/filix-mas* aggregate is well-known as a complex whose cytological relationships have yet to be worked out but the appearance of *D. aemula* as a breeding member in the complex has not hitherto been reported.

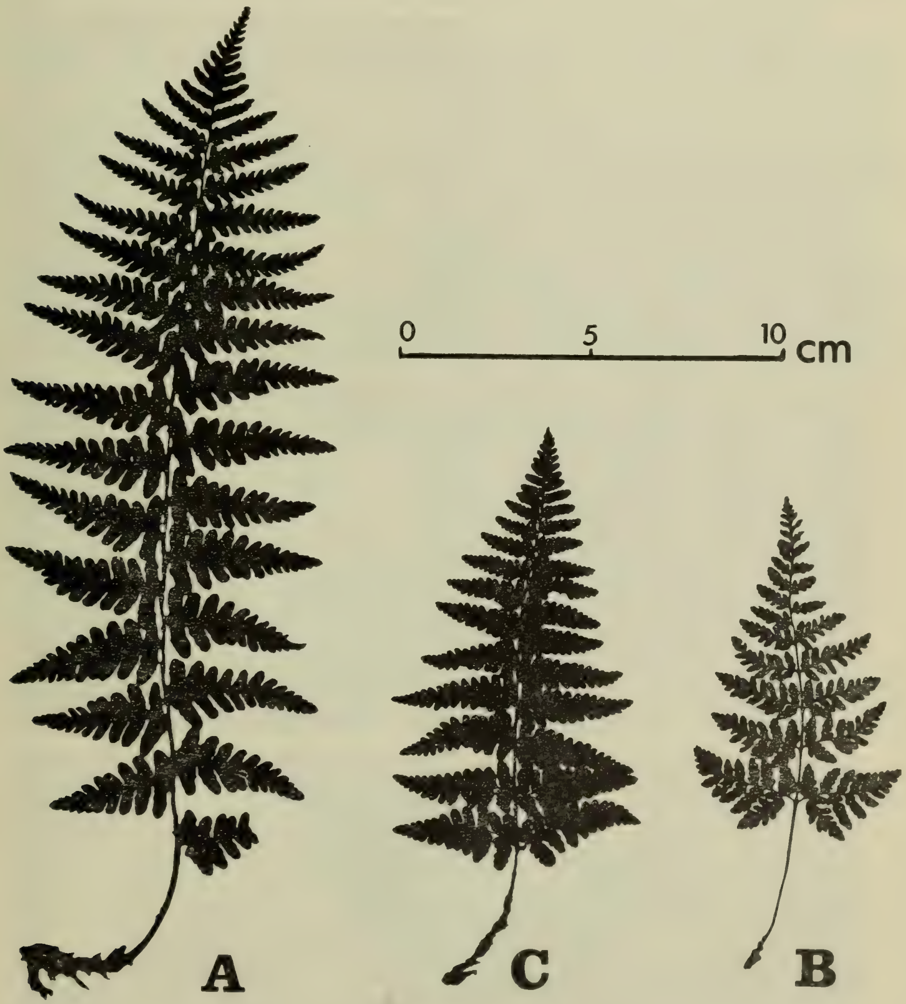

FIGURE 2: Silhouettes of *Dryopteris* fronds. **A:** *D. abbreviata*; **B:** *D. aemula*; **C:** *D.* × *pseudoabbreviata*.

Dryopteris × pseudoabbreviata Jermy **hybr. nov.** [Fig. 2]

Planta *D. abbreviatae* similis sed frondis textura tenue lamina crispa, costis denigratis, stipe ad basim purpurascente divergens, quibus characteribus accedit ad *D. aemulam* similis est.

Rhizome branched, sub-erect with several crowns, covered in pale gingery brown scales. Frond 10–12 cm; stipe 2–3 cm, lower half purplish (which accentuates on drying), densely scaly with triangular or long-attenuate paleae; lamina mid- or yellow-green, edges undulating, lanceolate and truncate at base or narrowly triangular (see fig. 2); lowest pinna 3 cm long × 1.5 cm wide, with pronounced lower basiscopic pinnules; pinnules oblong, overlapping at base, rounded and sharply dentate at apex, often projecting upwards giving crisp nature to frond; rhachis, costae and costules with pale concolourous scales. Sori 1 on the upper, to 8 on the lower, pinnules; indusium tucked under sporangia, glandular especially along edges. Spores of varying sizes to 60 μ, perispore profusely folded and mammillate.

TYPUS: On steep slopes of birch-hazel-oak wood above road, An Coire, Isle of Mull, Argyll, (v-c. 103) Nat. Grid Ref.: 17/681297. *Jermy* 6374, 12 Sept. 1967. Holotypus at **BM and in cult.** at Otford, Kent.

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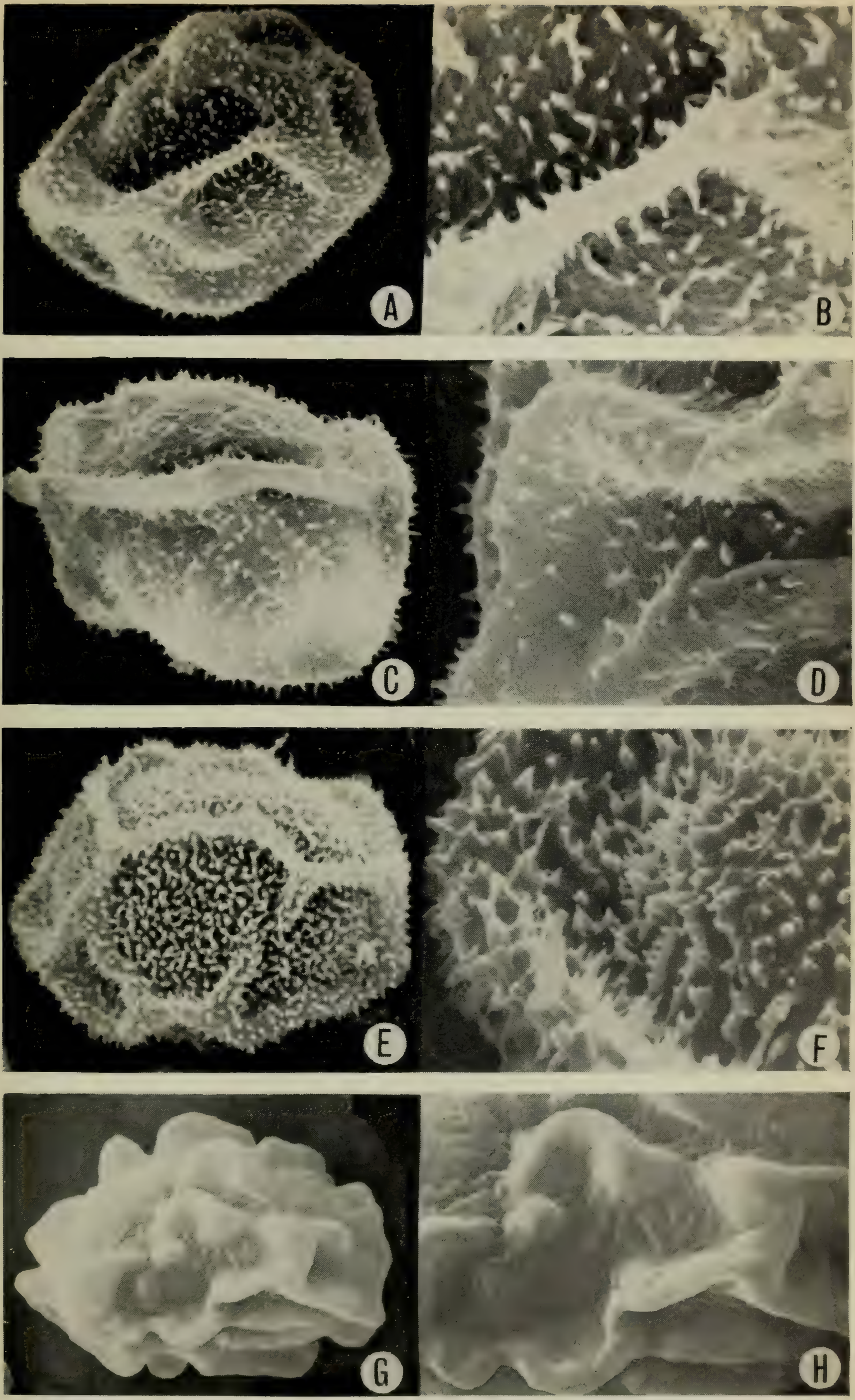

PLATE II: Spore ornamentation in *Dryopteris*. **A, B:** *D. assimilis*; **C, D:** *D. aemula* × *dilatata*; **E, F:** *D. dilatata*; **G, H:** *D. aemula*. Magnification: A, C, E, G × 1000; B, D, F, H × 3000.

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FERN HYBRIDISTS AND FERN HYBRIDISING
II. FERN HYBRIDISING AT THE UNIVERSITY OF LEEDS*

JOHN D. LOVIS**

INTRODUCTION

Under the direction of Professor Irene Manton, experiments involving the artificial hybridisation of ferns have been carried out in the Department of Botany in the University of Leeds for nearly twenty years. Accounts of the results of several individual experimental investigations have been published, but until now, although a brief account was provided some years ago by WALKER (1955), no detailed description of the method used for obtaining hybrids has been generally available.

The development of the programme for production of artificial fern hybrids at Leeds was a logical consequence of the achievement of MANTON (1950) in successfully overcoming, for the first time, the practical difficulties which had impeded accurate study of fern chromosomes. A variety of fern hybrids have since been synthesised because study of chromosome pairing in hybrids of known origin can give valuable information regarding the nature and degree of relationship existing between the parents.

The first studies on the chromosome number of artificial fern hybrids were made by DÖPP (1935, 1939), but nevertheless the first fern hybrids deliberately synthesised in order to obtain information regarding the chromosome pairing to be found in a particular hybrid combination were made by Manton, who in 1939, whilst still in Manchester, synthesised two hybrids between *Dryopteris filix-mas* and *D. abbreviata* (1950, p. 48), and later obtained also the combination *Polystichum aculeatum* ♀ × *P. setiferum* ♂, which produced sporangia for the first time in 1947 (1950, p. 154).

Subsequent to Manton taking up the Chair of Botany in the University of Leeds, fern hybridisation work was resumed, and gradually built up impetus, with the result that a very considerable number of interspecific hybrids have been raised at Leeds in the last fifteen years, involving species belonging to a number of different genera, namely *Adiantum*, *Aleuritopteris*, *Asplenium*, *Cyclosorus*, *Dryopteris*, *Phyllitis*, *Pleurosorus*, *Polypodium*, *Polystichum* and *Pteris*. During this time, a number of individuals have participated in the work. Of these, the most important names, in chronological order, are S. Walker, M. G. Walker (née Shivas), G. Panigrahi, T. G. Walker, J. D. Lovis, J. Ghatak, J. I. Souter (née Emmott), A. F. Braithwaite, A. Sleep, S. K. Roy, B. M. B. Sinha, and G. Vida.

Although details of the technique used at Leeds in hybridisations have gradually changed over the years, nevertheless the basic essentials of the method used have remained the same. No two workers have used exactly the same procedure, each one of us adopting various minor elaborations, though these personal variations have more often been based on intuition or just plain whimsy rather than possession of sound evidence indicating that the modification should improve chances of success! The actual hybridisation procedure described here is my own, as applied to *Asplenium*, which is chosen solely because I know it best.

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*Part I of this series (The Work of Edward Joseph Lowe, 1825–1900), appeared in *Brit. Fern Gaz.* **9:** 301–308 (1967).

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DIFFERENT METHODS FOR ATTEMPTING FERN HYBRIDISATION

In his pioneer experiments on fern hybridisation, E. J. LOWE (1895) used the most simple methods possible in his attempts to obtain hybrids. By making a dense sowing of a mixture of the spores of the intended parents, Lowe obtained cultures containing gametophytes growing together in close admixture. Relying upon the uncontrolled operation of the natural process of fertilisation within the culture to produce at least some hybrid sporophytes as well as the parental forms, Lowe separated and grew the entire sporophyte progeny of the culture, subsequently detecting the hybrid plants on the basis of their morphology.

Some[1] other workers who have similarly obtained hybrids by growing gametophytes of the two intended parents in close proximity, established their cultures by means more elaborate than a straightforward sowing of mixed spores, in the hope of increasing the chance of success. Thus P. Kestner (*fide* TAVEL 1937), transplanted developing gametophytes of the intended parents into the same culture vessel. FARMER informs us (1897) that Schneider, who obtained a very spectacular hybrid, *Polypodium* × *schneideri* [*Polypodium vulgare* var. *cornubiense* ×*Phlebodium aureum*][2], planted together prothalli of different age in order to counteract the very different growth rates of the prothalli produced by the two parents.

A yet more sophisticated procedure is that applied by SLOSSON (1902) who, in raising the hybrid *Asplenium* × *ebenoides* (*A. platyneuron* × *A. rhizophyllum*), planted a single castrated prothallus with a single entire prothallus from the other parent. However, she achieved an equal degree of success by planting together pairs of prothalli without castration of one species.

An interesting variant is that adopted by WAGNER (1956), who obtained success by placing a pot containing prothalli of one parent in such a position as to ensure that its surface would receive a rain of spores from plants of the other intended parent.

All procedures of this type have the same drawback, which becomes a serious disadvantage if an extensive series of hybrisations is planned, in the effort involved in sorting the hybrid plants from the parental types amongst the progeny. When it is desired to hybridise plants of closely similar morphology, as has often been the case in investigations at Leeds, this method is to all intents and purposes impracticable, and other more suitable means must be found.

In contrast to the methods outlined above, an entirely different principle has been adopted in all the hybridisation experiments at Leeds. Contact between the parent gametophytes is limited to a brief interval. Conditions are made as favourable as possible for the occurrence of cross-fertilisation during this period of contact. A limited number of prothalli intended to function as females are exposed in water to numerous prothalli of the other parent which are actively liberating spermatozoids, the concentration of spermatozoids being as intense as can be contrived. Release of spermatozoids is discouraged both before and after the hybridisation attempt.

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[1] It would be interesting to link this paper with the preceding part (LOVIS 1967) by a comprehensive survey of artificial fern hybridisation from the time of Lowe until the inception of the Leeds group. However, this has proved to be a larger and more complicated task than was expected, and must be postponed until a future date.

[2] In Farmer's paper, the names are different: var. *elegantissimum*=var. *cornubiense*, and *Polypodium glaucum*=*Phlebodium aureum*.

GATHERING AND SOWING SPORES

There are many ways of both gathering and sowing spores, and most readers of this journal will have already established favourite methods of their own, but the following comments may be of interest to some.

In harvesting spores, the most important requirement is to keep the spore sample as pure and free from contamination as is possible, and it is very often necessary first to wash the selected fronds under running water. This is an inconvenience, because such treatment leaves the fronds very wet, in the worst possible condition for being pressed or packeted. As a means of soaking up the adherent water from fronds without running the risk of cross-contamination, packs of cheap disposable paper tissues are of invaluable service. When considerable quantities of spores are required from one source, the use of packets made of grease-proof paper, hand-folded to a convenient size, is probably the best method. However, one often needs both a herbarium specimen and spores for sowing from the same frond. For large fronds 'flimsy' covers, such as are used by British Museum collectors, are ideal for saving spores from specimens in the press, but when either the frond is very small, or the sporangial area is very limited, then I prefer to slip an unfolded half-sheet of thinly glazed writing paper of moderate quality under the specimen as it goes into the press. It is worth experimenting to find a suitable grade of paper, for spores shed on to the right kind of paper will, if handled carefully, defy gravity in a very useful way. It is possible to make use of this faculty to make sowings of very small quantities of spores with a high degree of efficiency. Carefully remove the paper bearing the spores from the press (or from a pile of pressed specimens, which for this purpose are best stored in their original pressing paper), and slowly invert it over the sowing pot, taking care to centre it accurately. Then, holding the paper in position on the rim of the pot with the fingers of one hand, give it a sharp flick from a finger of the other hand, which will dislodge the spores. Allow the spores time to settle on the surface of the soil before removing the paper. If all the spores have not been dislodged from the paper with the first flick, repeat more vigorously.

It seems that different species of ferns differ widely in the length of time for which their spores remain viable. However, it is often rewarding to be optimistic, for many species retain viability for a long time if kept in a reasonably dry atmosphere without exposure to unusually high temperatures. For instance, the spores of many species of *Asplenium* are known to be long-lived. In the case of the *Asplenium trichomanes* species complex, useful germination has often been obtained from samples of spores more than ten years old. This is not put forward as any sort of record, but solely as an observation which has been several times confirmed.

CULTURE OF PROTHALLI

Hybridisations cannot be attempted without first obtaining cultures of healthy prothalli. It is possible to grow fern gametophytes successfully in agar culture, but our prothalli are grown exclusively on soil, using a compost made up of two parts peat, one part loam, and one part silver sand. This mixture is passed through a $\frac{1}{4}$ in. riddle, and is then steam-sterilised in order to kill not only the spores of pathogenic fungi and the eggs of various undesirable fauna, but also the spores of algae and bryophytes, which, if given the opportunity, can compete very successfully with germinating fern prothalli. For spore sowing pots (clay not plastic), with a diameter of 2½ in. inside the rim are used, these having been previously sterilised by boiling. Half of the pot is filled with drainage materials, consisting of mixed gravel and broken brick. The pot is then filled to within ½ in. of the top with the sterilised compost, which is then lightly compressed to give an even surface. A thin covering layer of the same compost is then added, using a ⅛ in. riddle. The pots are then covered with a "watch-glass" of appropriate size.[3] The watch-glass cover has the function of maintaining humidity, and even more important, of reducing the level of contamination by air-borne spores. It is essential that the watch-glass is placed on the pot convex-side uppermost, in order that the moisture formed by condensation on the lower surface of the glass shall run under the influence of gravity harmlessly to the sides of the pot. Placing the glass other side up would result in drops of water falling into the middle of the culture at regular intervals, producing unwanted fertilisations. For the same reason, flat covers are equally unsuitable.

Before sowing, the compost is moistened by the passage of water up through the pots by capillarity, the pots being stood in a trough of shallow water for this purpose. As a precaution against contamination and infection, the soil surface in the prepared pots is sprayed with a standard horticultural strength dilution of Orthocide Captan fungicide. The pots are then left to stand for two or three days, since there is some indication that sowing of spores immediately after an application of Captan can result in inhibition of germination, even to the extent of the sowing being a total failure.

The cultures are kept in closed frames in greenhouses. The pots are placed on a bed of broken coke or cinders, in the hope of reducing the depredations of slugs. Even the smallest slug can produce devastation amongst germling sporophytes, although fortunately these beasts do not seem to be at all interested in the gametophytes. All waterings of the cultures are invariably effected by soaking from the bottom upwards, in order to restrict the liberation of spermatozoids within the culture to a minimum. This has the effect of helping to retain the virginity of prothalli it is intended to use as females, and also of maintaining a higher concentration of mature antheridia in cultures intended for use as males.[4] Water is applied directly to the surface of a culture only when it is expressly desired to self-fertilise a particular strain. Occasionally, the cultures are watered with a dilute solution of potassium permanganate instead of tap water,[5] the potassium permanganate having some prophylactic value as a mild fungicide, and also causing any minute earthworms which may be present to declare themselves by rising to the surface of the pot. The presence of these animals under such conditions of cultivation is a marvel in itself, but they do sometimes appear, and can cause chaos by churning up the surface of a culture.

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[3] For convenience in handling, the size of the glass needs to be such that it lies flush with the rim of the pot.

[4] It is important that the level in the watering tray or trough is always kept shallow, the depth of water being no more than one inch. Higher levels cause an undesirable amount of water to rise to the surface of the soil. If a film of free water becomes established between the soil surface and the under-surfaces of the prothalli, liberation of spermatozoids may occur on a massive scale. When adding water to an empty trough, one needs to bear in mind that subsequent insertion of a complete batch of pots will by displacement considerably alter the level of the water.

[5] Tap water is used for watering our cultures. However, Leeds water is soft, and therefore we do not have to cope with the problems which are likely to arise when calcifuge species (such as *Asplenium septentrionale*), are cultivated in a district with an alkaline water supply. This is fortunate, because we know that rainwater obtained by the usual means of collecting roof drainage on our site (in an urban environment), often contains a lethal concentration of soluble pollution products. Probably the bulk of the harmful substances enter the water by solution from the soot deposit on the roof, rather than by absorption while in passage through the air as raindrops, but the task of collecting a sufficiency of rainwater by means other than from roof drainage would be formidable.

An alternative method of watering cultures is to plunge the pots almost up to their rims in a damp bed of graded cinders or peat. Owing to the porosity of the clay pots, sufficient water to sustain prothallial growth will enter the soil of the cultures from the surrounding material, which must be kept moist, but not waterlogged. This method is less demanding in terms of the time that needs to be spent looking after the cultures, and in circumstances where this consideration is of greater importance it may be preferable, but it is less economical in its use of space.

The chances of effecting a successful hybridisation are very materially influenced by the stage of development of the parent strains. Antheridia are formed on the developing prothallus before archegonia appear, but nevertheless although in older prothalli the antheridia are few in number in comparison with the number of archegonia, it is always likely that some antheridia are present. The appearance of a certain proportion of "self-fertilised" plants amongst the progeny obtained from hybridisation attempts must therefore be accepted as inevitable. In contrast to more crowded cultures where the prothalli suffer the influence of intense mutual competition, resulting in delay in the development of an archegonial stage and, if the investigator is fortunate, in the abundant production of antheridia, prothalli growing with room to spare will more quickly develop a band of mature archegonia. It is therefore helpful to make deliberately sparse sowings for eventual use as females, and to make dense sowings for use as a male parent. It is rarely possible to obtain an ideal dispersion of prothalli for use as females simply by control of the density of the spore sowing. Therefore, in preparation for their use as female parents, prothalli are 'pricked out' one by one from the original sowing pot and transferred on to another pot of soil, the individual prothalli being spaced at a distance of from ¼ to ½ in. apart from each other, according to the size and relative rate of growth of the particular strain involved. (Pots for this purpose are prepared in exactly the same manner as pots for sowings, the only difference being that pots of 3 in. diameter, not 2½ in., are used.) This operation is best carried out as soon as the prothalli are of a size to permit their being handled conveniently. Individuals differ in whether they prefer to use a pair of forceps or a mounted needle-knife for the transfer operation, but I myself find a pair of Dumont & Fils watch-maker's fine forceps unequalled for handling small prothalli. The S grade is convenient. Care should be taken to ensure that tiny young prothalli are not also transferred inadvertently, adhering to the undersurface of the chosen prothallus, otherwise the chance of subsequent premature fertilisations will be much increased. Spontaneous fertilisations occur much more readily amongst crowded cultures than they do in pots of isolated prothalli. Reduction in the rate of accidental fertilisations is just as important an advantage of 'pricking-out' prothalli as is the more rapid and even growth which follows separation. As a further precaution against self-fertilisation, I personally consider it wise to place each prothallus at such an angle that its growing point is well clear of the soil surface. It is helpful if the spaced prothalli can be kept for at least three weeks before use, in order that sporophytes produced by earlier unintended fertilisations may have a chance to declare themselves.[6]

It is not easy to bring two cultures to readiness in optimal condition for use against each other at the same time, because the problem of making correct decisions regarding sowing dates is complicated by such considerations as the state of the season,[7] and the vigour of growth characteristic of any particular species. For this reason it is prudent to make a series of sowings, staggered on to different dates, since this precaution may obviate the possibility of complete failure of the programme owing to miscalculation of speed of growth. Because of these same considerations, it is difficult to give any reliable guidance concerning the time likely to be required for a culture to develop sufficiently for use in hybridisations. The rate of growth will clearly also be very profoundly influenced by the actual conditions of culture. Under our cultural conditions, using mostly south-facing frames in heated greenhouses producing a range of minimum temperatures in the frames from 50 to 70 degrees Fahrenheit, prothalli may become ready for use as a source of spermatozoids in anything from ten weeks to six months after the date of sowing, depending upon all the circumstances. For sowings made in the period late January—early March, three to four months is usual. If watered very carefully, a culture may then remain in suitable condition for use as a male parent for several weeks.[8] It is a good idea to sow some cultures to provide prothalli for use as females some four to six weeks before the first sowings intended for use as a male parent, since even when prothalli are freed from competition by 'pricking-out', a culture may require from four to eight weeks longer to produce prothalli suitable as females than it would need to be ready for use as a source of spermatozoids.

HYBRIDISATION TECHNIQUE

The actual process of hybridisation is very simple. A small portion of prothalli, say ¼ in. square, is removed from the culture of the intended male parent, which will nearly always be a dense culture in a relatively early stage of growth. The prothalli are teased apart in a little warm water (25–30 degrees Centigrade—in effect, with the chill just taken off).[9] In Leeds, ordinary tap water is quite safe for this purpose. The watch-glass is then placed on the bench with an ordinary 40 watt bench lamp suspended twelve inches above the prothalli. (When weather conditions permit, the use of sunlight instead of an artificial light source sometimes produces most successful results.) At intervals during the next twenty minutes the watch-glass is examined under a microscope in order to determine whether an adequate number of sufficiently vigorous spermatozoids is being released. Judgement of what is in fact 'adequate' and what is 'sufficiently vigorous' will depend upon the optimism of the experimenter! As soon as a culture is found by this means to be behaving suitably, more 'male' prothalli are added to the watch-glass and if necessary, a little more water. Without delay, a small number of prothalli (8–12, according to choice), from the intended female parent are selected, quickly cleaned of soil and detritus (and other small prothalli, if present!), inspected to make sure that an incipient sporophyte is not present, and then placed carefully with dorsal surface uppermost at equidistant points in the watch-glass, which is then returned to a position under the lamp, covered with another slightly larger (2½ in. diameter) watch-glass in order to prevent the hybridisation drying out, labelled, and left undisturbed for some time. Within reasonable limits, it is not important just how long the 'female' prothalli are left in contact with the 'males'. The hybridisation attempt ought to be left undisturbed for, at the very least, half an hour, and preferably for one hour. On the other hand, it is quite permissible, if circumstances make it desirable, to leave the hybridisation overnight, only making sure that it does not dry out completely during this time. The process is completed by removal of the 'female' prothalli, which should then be cleaned thoroughly, washed in fresh water two or three times, and then most carefully examined in order to ensure that tiny 'male' prothalli are not inadvertently carried over. If the experimenter is wise, he will have selected to act as females prothalli which in some way are distinguishable from the prothalli of the male parent, otherwise unfortunate mistakes may occur at this stage. The inspected prothalli are transferred to fresh soil in another 3 in. pot (prepared exactly as before). The prothalli are spaced equidistantly to facilitate separation of the subsequent sporophytes.

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[6] A point of interest regarding the culture of prothalli, one which has obvious ecological implications, is that it has been found that pots of prothalli can survive several weeks of apparently complete dryness, so long as no sunlight falls on the withered prothalli, and so long as the atmosphere is kept humid. A wooden box with a glass cover on the soil under the greenhouse staging provides such conditions, and it is possible in this way to retain a precious culture over two seasons, permitting it only a minimum of water at long intervals as a safety measure. When it is wished to stimulate growth once more, the pot is watered in the usual way, but is still protected from sunlight. Once turgidity is restored, the culture can, by degrees, be safely returned to a normal position in the frames. At present, it is not known how general this drought tolerance is amongst fern gametophytes. It has been found in several species of *Asplenium*, and in *Polystichum*, but as yet we have not tested other genera.

[7] Successful hybridsations can be obtained at any time of year provided, of course, that cultures in suitable conditions are available.

[8] When a particular active male culture is especially valuable, it may be worth the trouble to 'hold' it in condition by removing it from the frame and plunging it in only slightly moist peat inside a glass-covered box under a bench on the shady side of the greenhouse, subsequently applying to the peat only just sufficient moisture to keep the prothalli turgid.

[9] Add a sufficiency of hot water to a reservoir of cold water to get the required temperature. It is probably unwise to use water which has been overheated and then cooled, because the deoxygenation of the water on heating may still persist, and aversely affect the activity of the spermatozoa.

It now remains only to await results. The time of appearance of hybrid progeny will vary according to their innate vigour and the season of the year. Hybrid sporophytes may not become evident, even as a first frondlet, until one month or six weeks after hybridisation, or even longer, while any sporophytes which become evident before three weeks have elapsed will most probably prove to be the product of self-fertilisation before the hybridisation was attempted. Sometimes a single prothallus will produce two or more sporophytes simultaneously. As long as not more than the first three leaves have expanded, it is usually possible, by using a very sharp scalpel, to divide the prothallus cleanly, and then one can uproot the young plants successfully and replant them at a more reasonable distance apart.

In general, it does seem to be easier to obtain satisfactory 'swims' of spermatozoids during the morning than at other times of the day. This observation should however, be treated with reserve. It may not be true of all species, nor of all conditions of cultivation. Indeed, no aspect of the process of hybridisation or of the growing techniques has been subjected by us to carefully controlled experimentation in order to determine optimum conditions and procedure. All workers have been more interested in acquiring hybrids than in details of technique, and we have been concerned to devise convenient methods that produce satisfactory results, rather than to labour at length in order to discover the best possible or most efficient technique.

It is known, however, that our technique of hybridisation can be highly effective. Where closely related and highly compatible strains have been hybridised together, success has often exceeded 80%, and has sometimes approached 100%. Other hybrid combinations, including those such as *Asplenium* × *alternifolium* which appear at least in certain localities to form with ease in nature, may prove to be extremely difficult to synthesise in the laboratory, and the experimenter may have to content himself with rates of success of the order of 1% and even much lower. In such cases, it is presumably a natural lack of affinity, or in other words, reduced compatibility, which frustrates the hybridisation attempts. Some combinations must of course be impossible, owing to total incompatibility between the two intended parents. The cardinal but, alas, insoluble dilemma of the persevering hybridist is to distinguish between what is merely extremely difficult, and what is quite impossible. In the former case persistence may bring a triumphant reward, but in the latter circumstances whatever the scale of the attempt, the result can only be a fruitless waste of time and effort.

In conclusion, this is a most fitting place to pay tribute not only to Professor Irene Manton, who instigated and directs the research programme on fern cytogenetics in the Department of Botany at the University of Leeds, and established the horticultural facilties which have made it possible for her students and associates to engage successfully on a large scale in hybridisation work, but also to the staff of the Department's Experimental Gardens, and in particular to Mr Peter Lee and Mr Frank Horwood, who have for many years spent much of their time caring for the cultures used in our experiments.

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TAXONOMIC NOTES ON JAMAICAN FERNS—II

G. R. PROCTOR*

The present paper is a sequel to one published in this journal in 1965 (vol. 9: 213-221). The intervening period has produced a number of interesting publications by various authors, dealing directly with Jamaican ferns or with the nomenclature of species which occur in Jamaica. However, as one might expect with so complex a subject, disagreements of interpretation have occurred. In the present article I wish to discuss a few of these. Proposed are one new species, four new combinations, and a new name for a species previously published as a variety.

ASPLENIUM AURITUM var. PARVULUM

Asplenium **jenmanii** Proctor, **nom. nov.,** based on *Asplenium auritum* Sw. var. *parvulum* Jenman in Bull. Bot. Dept. Jamaica N.S. **1** (2): 30 (1894); *A. cuspidatum* Lam. var. *parvulum* (Jenman) Morton & Lellinger in Mem. N.Y. Bot. Gard **15:** 28 (1966) (non *Asplenium parvulum* Wall., etc.). **Type** from an unknown locality in the parish of Portland, Jamaica, **J.P.** 396 **(IJ).** [Note: Morton & Lellinger, op. cit. 29, stated that this specimen is "in the herbarium at Hope Gardens, Jamaica". However, the old Hope herbarium was transferred to the University of the West Indies many years ago, with the exception of the ferns, which are deposited at the Institute of Jamaica. There is now no herbarium at Hope Gardens.]

Recent rediscovery of this plant in Jamaica, in rather abundant populations occurring in the valley of the Stony River, Parish of Portland (*Proctor 28281* and *28376*, collected July 24 and 25, 1967), has emphasized characters suggesting that this entity is better treated as an independent species. The uniformly smaller and thinner texture of these fully mature plants are not connected by any known intermediates with typical *A. auritum* or *A. fragrans* Sw. (*A. cuspidatum* var. *tripinnatum* (Fourn.) Morton & Lellinger). Further, *A. jenmanii* is distinctive in being prolifically stoloniferous, a character not observed in either of the two species with which it has usually been associated. The stolons are fragile and not always obvious in herbarium specimens, but this is evidently the means by which *A. jenmanii* spreads to form extensive clones.

The new name proposed for this species commemorates G. S. Jenman, who from 1873 to 1879 was Superintendent of Botanic Gardens in Jamaica, and who published extensively on the ferns of Jamaica and other West Indian islands.

LONCHITIS versus BLOTIELLA

Lonchitis aurita L. has long been considered the type of the genus *Lonchitis*, but in 1962 (in Contr. Gray Herb. **191:** 93-100) R. M. Tryon published a paper in which he expressed the opinion that this generic name has usually been misapplied. His reasons for this were that the type (Plumier, Fil. *t. 17*, based on a plant from Martinique and here reproduced as Fig. 1) "is composed of two discordant elements (species) combined into one illustration" and also that the Plumier plate "does not represent any known species", presumably because no one since Plumier has found in Martinique a plant corresponding with this plate.

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Tryon expressed the belief that since there are discrepancies between the Plumier drawing and the species whose Jamaican representative has been known as *Lonchitis aurita* L. [since Jenman identified it as such in the late nineteenth century (see Bull. Bot. Dept. Jamaica no. **40:** 10, 1893)], then the name *Lonchitis*

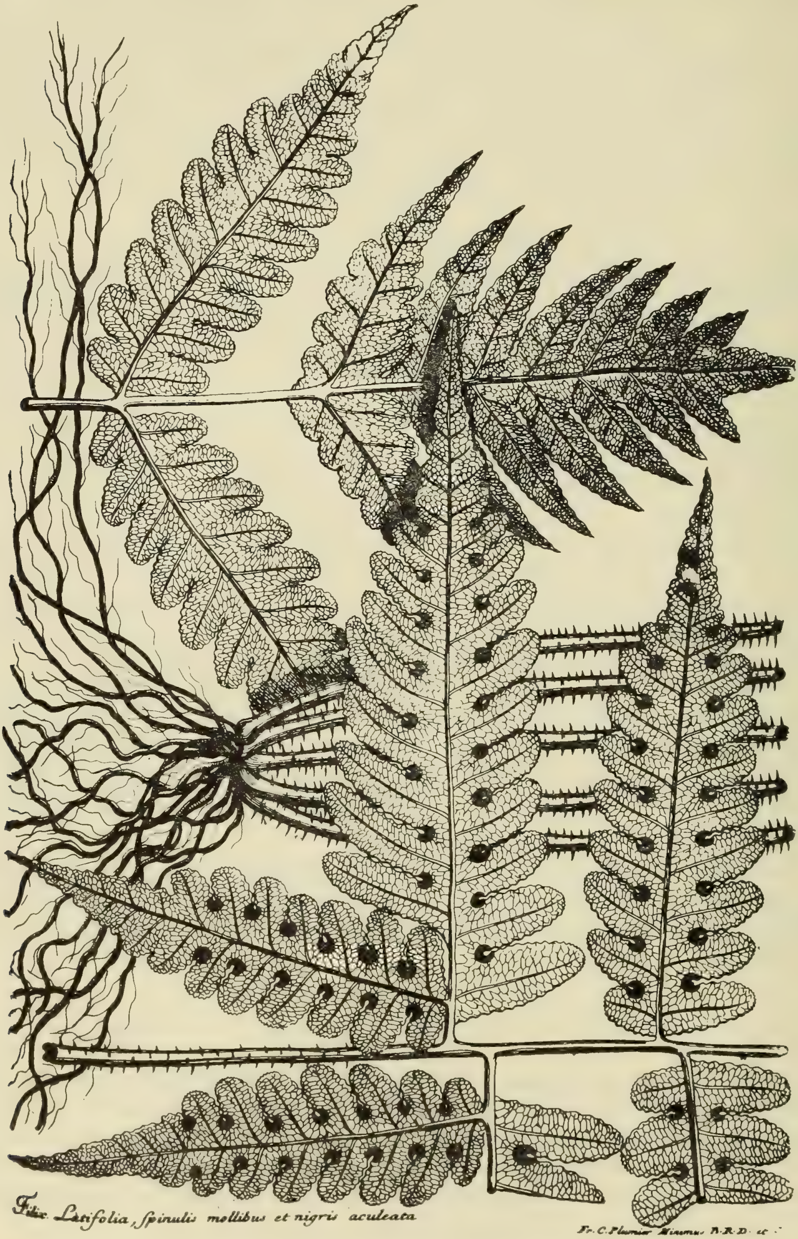

Filix. Latifolia, ſpinulis mollibus et nigris aculeata
Fr. C. Plumier Minimus R.R.D. etc.

FIGURE 1: Tab. 17 from C. Plumier's *Tractatus de Filicibus Americanus* (1705).

must be applied to the other element of the Linnaean taxon, namely the species now usually called *Anisosorus hirsutus* (L.) Maxon. This left the material customarily called *L. aurita* without a generic name, and for it he coined the epithet *Blotiella*.

In a subsequent publication C. V. Morton (in Contr. U.S. Nat. Herb. **38:** 49-50, 1967) accepted *Blotiella* while disagreeing with some of Tryon's argument. He rightly pointed out that it is quite unlikely for Plumier's plate to have been based on a mixture of *Lonchitis hirsuta* L. (a free-veined species also illustrated by Plumier *t. 20*) and some unidentified species of *Pteris*. But he too thinks that an unknown areolate *Pteris* was the basis of the plate, because (as he puts it), "*Lonchitis* as generally delimited does not grow in Martinique".

I find it necessary to disagree with both Tryon and Morton as to the last conclusion. Certainly *Lonchitis* grows (or did grow) in Martinique, for Plumier found it there. There is no known species of fern that resembles Plumier's plate as closely as the Jamaican and South American plant we have been calling *L. aurita*. It may have been exterminated in Martinique since the time of Plumier, or it may yet be found there again. But the resemblance is too striking, in my opinion, to be mere coincidence. It seems far more reasonable to assume the common identity of the Jamaican and South American plant with Plumier's *t. 17*, than to postulate a large unknown Martinique species of *Pteris* for whose existence there is no other shred of evidence. One must also bear in mind that a large number of Plumier plates (more than 50) are types of fern species. Most of them are technically deficient in one way or another (but nevertheless identifiable), and if we were to discredit all in which some detail or other is wrong, there would be considerable slaughter among the earliest fern names. I think it quite unnecessary to discard *Lonchitis aurita* L. (based on Plumier's *t. 17*) as a valid species, and shall continue both to regard it as the type species of the genus *Lonchitis*, and to apply the name to the Jamaican plant identified as such by Jenman and most later fern students.

PITYROGRAMMA TRIANGULATA

Pityrogramma triangulata (Jenman) Maxon in Contr. U.S. Nat. Herb. **17:** 173 (1913). *Gymnogramma triangulata* Jenman in Bull. Bot. Dept. Jamaica N.S. **4:** 206 (1897).

The genus *Pityrogramma* was last discussed as a whole by R. M. Tryon (in Contr. Gray Herb. **189:** 52–74, 1962) in a useful paper that brought a measure of order to a relatively small taxon whose species have often been misinterpreted. However, he treated as "dubious" a Jamaican species not often collected, for which perhaps the material he had at hand was inadequate. The purpose of the present note is to shed a little further light on this species.

P. triangulata is a species of quite restricted range but, although rare, where it does grow one finds it in some abundance. One such locality occurs along the trail leading from Mt Airy through Mt Cressy to Fox's Gap, Parish of St Andrew. Here, at an elevation of about 3200 ft (c. 1000 metres), numerous small plants grow along the trail and on adjacent banks. Nearby slopes, denuded long ago by fire and now supporting a dense scrubby growth, contain dense clumps of the Pityrogramma, which in its texture and growth-habit is not unlike *P. ebenea*. The latter, incidentally, does not grow in this area, nor does any other species of the genus. The locality is far from human habitations. Tryon has suggested that *P. triangulata* is a hybrid between cultivated material of the African *P. argentea* and some local species ("most likely – – – *P. calomelanos*"). However, I can find no record that *P. argentea* has ever been under cultivation in Jamaica, nor can I see any particular resemblance to *P. calomelanos*. In texture, *P. triangulata* is stiff, and rather wiry, most resembling *P. ebenea* in this respect, and never of the "thin, slack texture" described by Christensen for *P. argentea* (Dansk Bot. Ark. **7**: 112, 1932). Further, the farinaceous powder of *P. triangulata* is pure white, copious and rather dense (at least on fresh material) instead of whitish or pale yellow, thin and scant in *P. argentea*. The blades of *P. triangulata* are always deltate and never more than 3-pinnate, with ultimate divisions varying from broadly ovate (almost rotund) in juvenile fronds to deltate or narrowly oblong-deltate with strongly revolute margins in fully mature fronds. The blades of *P. argentea* vary from lanceate to deltate-elongate, and from 3- to 5-pinnate, with ultimate divisions cuneate and emarginate or cleft. The venation of *P. triangulata* is more or less flabellately-veined as implied by Tryon, but unlike *P. argentea* it is copiously branched within individual ultimate divisions, and in larger ones there is usually some development of a mid-vein toward the base. No doubt there are other distinctive differences from *P. argentea* which a careful comparative study would disclose. The foregoing contrasts indicate that *P. triangulata* deserves full recognition as an endemic Jamaican species, related probably to *P. ebenea*. It is clearly distinct from the latter, however.

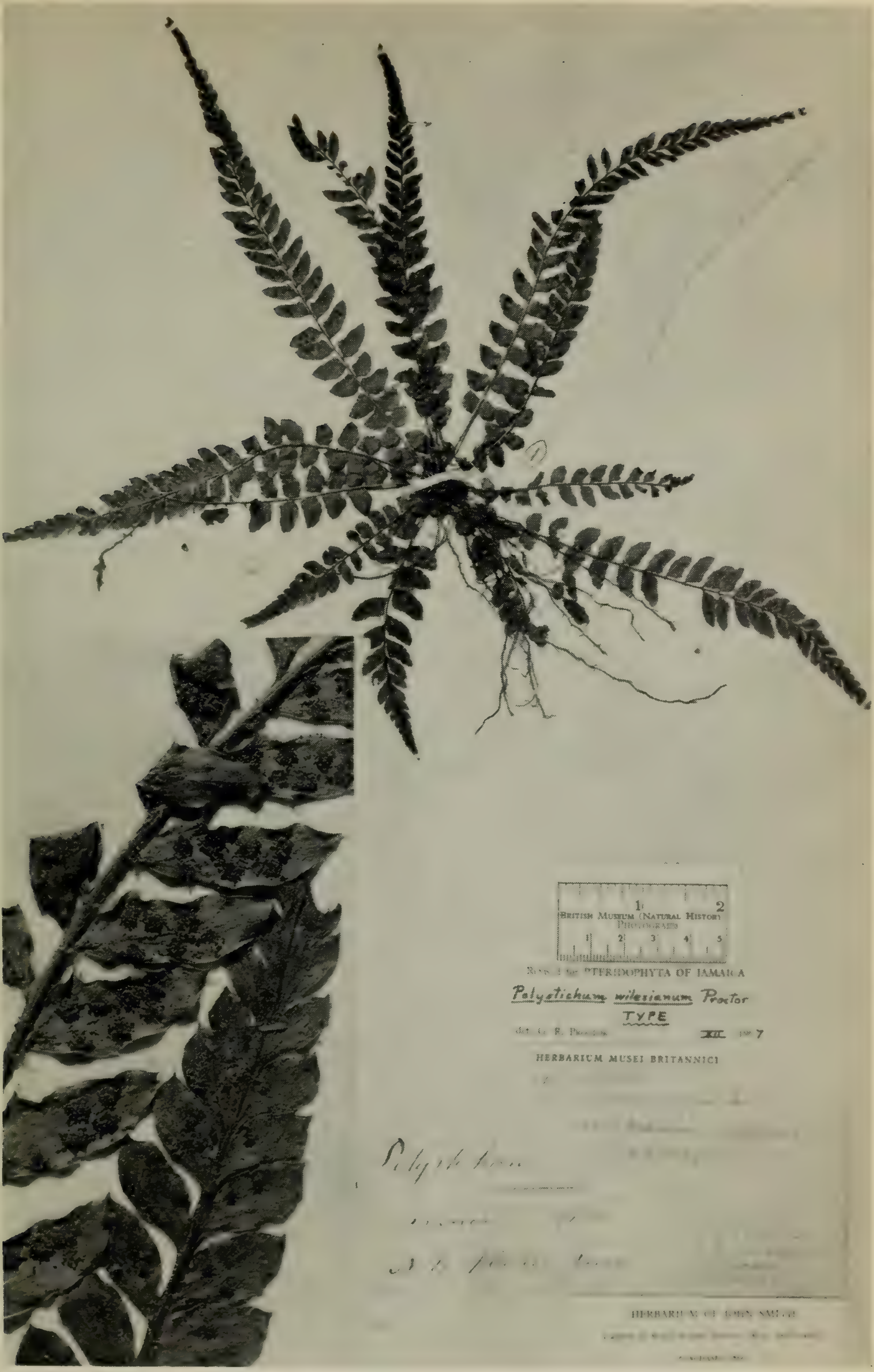
A NEW SPECIES OF POLYSTICHUM

Polystichum **wilesianum** Proctor, **sp. nov.** (Plate III); *Aspidium viviparum* var. *wilesianum* Jenman, ined.

Polysticho underwoodii Maxon affinis sed differt squamis concoloris parvioribus, stipitibus brevissimis et frondibus anguste lanceolatis-linearibus.

Rhizome small, ascending, c. 1 cm long, 3–4 mm thick, clothed at apex with rigid, dark brown or blackish, bullate, lanceate scales 2–3 mm long, these all concolorous. Fronds numerous, fasciculate, spreading, with very short stipes 1–2.5 cm long these bearing a few narrow, light brown, hair-pointed scales. Blades narrowly lanceolate-linear, 8–15 cm long, 1.2–2.4 cm broad, 1-pinnate nearly to the tip of the long attenuate, retuse, minutely proliferous apex; rhachis finely fibrillose-scaly; pinnae numerous, simple, ovate to narrowly rhombic-oblong from a strongly inequilateral base, chiefly 8–13 mm long, 4–7 mm broad, abruptly acuminate-mucronate, faintly auriculate at base on distal side, the lobe minutely mucronate; tissue papery, sparsely and finely fibrillose-scaly beneath; veins oblique, 1–3-forked. Sori inframedial; indusium nearly entire to lightly erose, deciduous.

Type from Jamaica, without exact locality (**Wiles s.n. BM**, photo IJ). Known only from the type specimen. The collector was James Wiles, who was associated with Captain Bligh in the introduction of breadfruit and other plants to Jamaica in 1793. He remained in Jamaica in charge of the botanical gardens at Bath, and during the following decade or longer collected a number of interesting botanical specimens now preserved at the British Museum (Natural History) and a few other institutions.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BRITISH MUSEUM (NATURAL HISTORY)
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PTERIDOPHYTA OF JAMAICA
Polystichum wilesianum Proctor
TYPE
det. G. R. Proctor
XII 1967
HERBARIUM MUSEI BRITANNICI
HERBARIUM OF JOHN SMITH

PLATE III

to face page 24

The present new species was seen and annotated long ago by G. S. Jenman as a variety of "*Aspidium viviparum*" as then understood, but apparently he kept no notes, and when publishing his "Synoptical List of Jamaican Ferns" he rather casually included this material in his concept of *Aspidium viviparum* subsp. *latipinnum* (in Bull. Bot. Dept. Jamaica N.S.**2** : 269, 1895). Maxon redescribed the latter entity as *Polystichum underwoodii* (in Contr. U.S. Nat. Herb. **13**: 38, *t. 9*, 1909). However, *P. wilesianum* amply differs from *P. underwoodii* in its smaller, concolorous rhizome-scales, very short stipes, smaller and differently shaped blades, and other details. It is unfortunate that no one has found this plant since Wiles, but the extant material suggests a distinct species worthy of recognition.

NEW COMBINATIONS IN CYATHEA AND THELYPTERIS

Cyathea **estelae** (Riba) Proctor, **comb. nov.**, based on *Alsophila estelae* Riba in Rhodora **69**: 67, f. 5–7 (1967). **Type** from north slope of Mt Horeb, Parish of Portland, Jamaica, **Riba 214 (MEXU, isotype GH).**

The recent discovery of this species suggest that still more tree-fern novelties may yet be found in the extensive montane rain-forest areas of eastern Jamaica. The present writer agrees with Holttum (Fl. Males. II, **1** (2): 73, 1963) in uniting *Alsophila* with *Cyathea.*

Thelypteris **basiattenuata** (Jenman) Proctor, **comb. nov.**, based on *Nephrodium basiattenuatum* Jenman in Gard. Chron. III, **15**: 330 (1894); *Dryopteris basiattenuata* (Jenman) C. Chr., Index Fil. 254 (1905). **Type** from Mt Moses, Parish of St Andrew, Jamaica, **J.P. 368 (IJ).**

Known only from the type specimen, which consists of five detached fronds. Despite their small size (9–12 cm long, 2.5–3.5 cm broad below the middle), the blades are fully bipinnate, a somewhat unusual character in *Thelypteris*; several other details set this species off as distinct from its congeners.

Thelypteris **lunaniana** (Heward) Proctor, **comb. nov.**, based on *Polypodium lunanianum* Heward in Mag. Nat. Hist. II, **2**: 460 (1838). **Type** from near Wellington Plantation, Parish of Manchester, Jamaica, **Heward s.n. (K).** *Thelypteris serrulata* (Sw.) Proctor in Bull. Inst. Jamaica Sci. Ser. **5**: 65 (1953), non Ching in Bull. Fan Mem. Inst. Biol. **6**: 319 (1936).

It is unfortunate that the well-known name *serrulata* cannot continue to be used for the Jamaican species with which it has been associated since 1801. Heward's epithet commemorates John Lunan, who in 1814 published a 2-volume work entitled "Hortus Jamaicensis".

Thelypteris **nimbata** (Jenman) Proctor, **comb. nov.**, based on *Nephrodium nimbatum* Jenman in Gard. Chron. III, **15**: 264 (1894); *Dryopteris nimbata* (Jenman) C. Chr., Index Fil. 279 (1905). **Lectotype** from Moody's Gap, Jamaica, **Jenman 2,** [in 1875] **(K).** Also collected at the same locality by *Harris, no. 7430* (BM, IJ, K).

A distinct species apparently related to *T. oligocarpa* (H. & B. ex Willd.) Ching, but more robust in all its parts, with much longer hairs on the stipe, with freely glandular-resinous but nearly glabrous tissue beneath (instead of pubescent with erect, hamate hairs), and nearly medial (instead of submarginal) sori with much larger indusium.

THE PROTHALLUS OF *MATTEUCCIA PENSYLVANICA*

B. K. NAYAR*

Matteuccia is a small genus, long regarded as consisting of two species, *M. struthiopteris* (L.) Todaro and *M. orientalis* (Hook.) Trev. However, three other species (*M. cavaleriana* (Christ) C. Chr., *M. japonica* (Hayata) C. Chr. and *M. pensylvanica* (Willd.) Raymond), all related to *M. struthiopteris*, are currently recognised. Along with its two monotypic sister genera (*Onoclea*, *Onocleopsis*) *Matteuccia* constitutes a group of ferns of ambiguous affinities. The morphology of the gametophytes of *Onoclea* and *M. struthiopteris* has been known for long (CAMPBELL 1887, 1895; LAGERBERG 1908; ORTH 1936; MOMOSE 1958; GANETT and ARNOTT 1965). Though the prothallus of both are of the cordate type, it is profusely hairy from the early stages of development in *Onoclea* and naked in *M. struthiopteris*; also there is a marked difference in their developmental history in the two species. In 1961 I described the prothallus of the Himalayan species, *Matteuccia orientalis*; the prothallus is cordate, hairy when mature but naked when young, and having a developmental history different from both *Onoclea* and *M. struthiopteris*. This variation in prothallial morphology is interesting in view of the ambiguous systematic position of these ferns, and particularly so as *M. orientalis* is regarded as a genus (*Pentarhizidium*) separate from the other species of *Matteuccia* by some pteridologists (HAYATA 1927). The present study was therefore undertaken to verify how far the gametophyte of the other species of *Matteuccia* conform with the three types so far reported in the group, and whether the differences in the morphology of the gametophyte of *M. orientalis* (*Pentarhizidium*) from that of *M. struthiopteris* support the generic separation of the two. As described below, the prothallus of *M. pensylvanica* is morphologically similar to that of *M. struthiopteris* and thus different from those of *M. orientalis* and *Onoclea*. However, the plane of cell division at spore germination in *M. pensylvanica* is different from that of both, resembling the condition reported in the Gleicheniaceae (STOKEY 1950) and in *Christiopteris* (NAYAR 1967).

Spores for this study were obtained from plants cultivated in the Botanic Garden of the University of California (Berkeley). Prothalli were raised on sterilised nutrient agar medium in petridishes maintained at 24 ± 2°C and 600 ft-c light intensity (NAYAR 1962). Spore morphology is studied from acetolysed (ERDTMAN 1951) as well as untreated spores. Methods followed in spore description and study are the same as reported by me earlier (NAYAR 1964).

The spore of *M. pensylvanica* is of the bilateral type with a golden-brown, thin, smooth exine and a loose, densely granulose perine which is wrinkled into a few sparse, light folds. On an average the spores measure 44 × 60 μ (polar diameter × longest equatorial diameter, exclusive of the perine which protudes c 10 μ from the exine surface). On sowing, the spore develops chloroplasts and divides by a wall parallel to its polar axis, separating a small rhizoid initial from the larger prothallial cell (Fig. 1). Most of the chloroplastids are contained in the prothallial cell, but the rhizoid initial also contains a few scattered plastids. In many cases the rhizoid initial remains inactive (Fig. 4), but mostly it soon elongates to form the first rhizoid. The prothallial cell, meanwhile, enlarges, splitting the spore-coat into two valves. It divides by a wall parallel to the first wall, cutting off a large basal cell (next to the first rhizoid) and a smaller anterior cell (Fig. 2). The basal cell may produce one or two lateral rhizoids. The anterior cell grows out as a uniseriate germ filament by a series of divisions parallel to the first two divisions. However, in some cases the anterior cell, instead of producing a uniseriate germ filament, may divide longitudinally; the basal cell may also divide longitudinally, resulting in a circular plate of cells (Fig. 5). Generally a uniseriate filament is produced by one of the daughter cells of the anterior cell (Fig. 8) but sometimes both the anterior daughter cells are active and a two-cell broad strap-shaped filament results. Whichever the case, the first division in the germinating spore of *M. pensylvanica* is by a wall parallel to the polar axis; the first rhizoid is equatorial in

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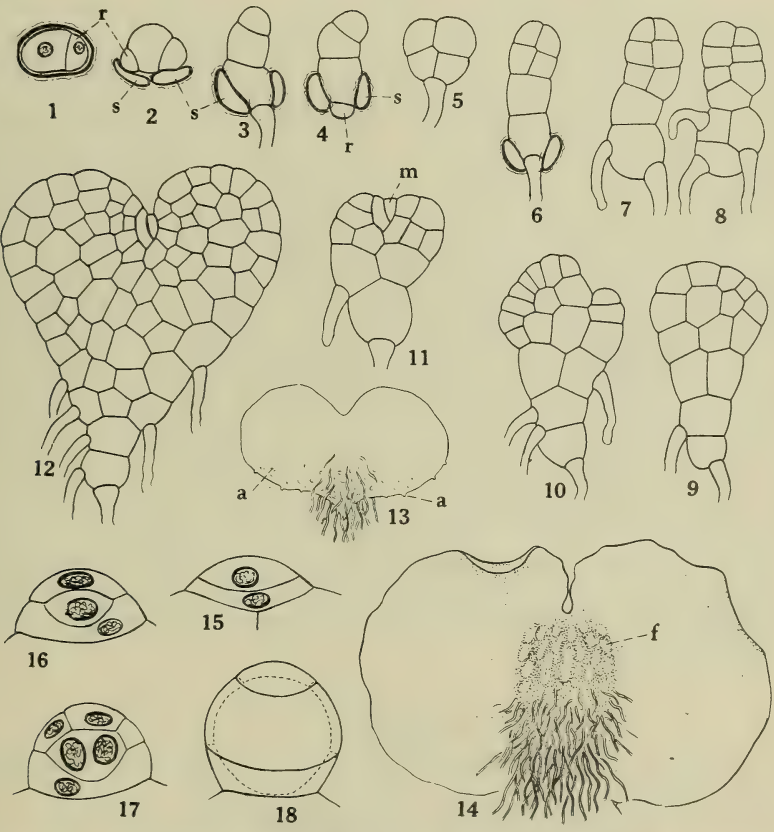
*National Botanic Gardens, Lucknow



FIGURES 1–18: Morphology of the prothallus of *Matteuccia pensylvanica*. (*a*–antheridium, *f*–archegonium, *m*–meristematic cell, *r*–rhizoid initial, *s*–spore coat). **1.** Germinating spore (proximal face downwards), showing first cell division. **2.** Same, showing second division. **3, 4.** Germ filaments. **5.** An uncommon case, where a plate of cells is formed at spore germination. **6, 7.** Initiation of plate formation. **8.** Same, in a germ filament which developed from a plate of cells as in fig. 5. **9, 10.** Young non-meristic prothalli. **11.** Young prothallus in which a meristematic cell has become differentiated. **12.** Development of a cordate apex in a young prothallus. **13.** Young cordate prothallus, nearly six weeks old. **14.** Mature prothallus. **15–17.** Stages in the development of antheridium. **18.** Mature antheridium.

position instead of polar, and the germ filament and the first rhizoid elongate in the plane parallel to the equatorial axis of the spore.

The germ filament usually becomes three or four cells long (Figs 3, 4) when its anterior cell divides longitudinally, initiating the formation of a prothallial plate (Figs 7, 8). The basal cell and usually the cell next to it remain uniseriate throughout. The anterior end of the prothallus expands and becomes spatulate (three or four cells broad at the apex) before an obconical meristematic cell is differentiated at the apex (Figs 9, 11); in many cases the formation of a meristematic cell is delayed further (Fig. 10) and in some cases omitted. Also, irregular development and branching (the marginal cells growing out as short uniseriate filaments) are rarely met with.

The prothalli grow rapidly and become distinctly spatulate with a broad apex (eight to ten cells broad) in about two weeks after spore germination. The apex soon becomes cordate (Fig. 12) and later the meristematic cell is replaced by a pleuricellular meristem in the usual manner. The prothalli reach maturity in about two months after spore-germination and attain nearly full growth in about another month. The mature prothallus (Fig. 14) is cordate, broader than long, naked, with broad spreadout wings and a median heavy midrib bearing archegonia and rhizoids on the lower surface. The rhizoids are nearly hyaline and non-chlorophyllous on the adult prothallus; early rhizoids on young prothalli may contain a few stray plastids. Antheridia are produced from the cordate stage onwards and are usually restricted to the posterior half of the prothallus, spreading to the wings and borne even marginally (Fig. 13). Archegonia are restricted to the midrib of the anterior half. Often on full-grown prothalli no antheridia are met with. The antheridium (Fig. 18) is large and subglobose with the usual type of development and structure met with in advanced ferns. The antheridial initial is a broad lens-shaped cell. The first wall formed in it is transverse and slightly curved downwards in the middle (Fig. 15). It curves prominently downwards before the second wall is formed, cutting off the central androgonial cell (Fig. 16). The androgonial cell is at first shaped like a biconvex lens; later it enlarges markedly and becomes subglobose (Fig. 17). The cap cell is comparatively narrow and is shed to release the sperms. The archegonia are also of the common type found in advanced ferns. The neck is four or five cells long, rather stout and curved away from the apex of the prothallus; the neck canal cell is binucleate and swollen towards the tip at maturity.

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A NEW *SELAGINELLA* FROM ZAMBIA

A. C. JERMY*

When studying African Selaginellaceae for an account for Flora Zambesiaca[1] my attention was drawn by Dr Frances Jarrett to unidentified specimens of *Selaginella* in the Kew Herbarium that had no close affinity to any other African species. The plants superficially resembled, in stature, in growth habit and also in habitat, *S. uliginosa* (Labill.) Spring (subgenus *Selaginella*) from Australia; the secondary and tertiary branches of the Africa species however, showed a differentiation in median and lateral leaves which were nevertheless less distinct than those of most species of the subgenus *Stachygynandrum* to which this species must belong.

Selaginella subisophylla Jermy **sp. nov.** [Figs. 1–9]

Planta erecta, 9–15 cm alta, rhizophora basi vel ex axillis ramorum imorum emittens. *Rami* inferiores ordinis primae ad 3 cm longi, 1–2-furcati, superiores ordini secundae sensim diminuentes, ramuli ultimi 3 mm longi; ambitus totius systematis ramificationis ubi complanati plerumque lanceolatus vel anguste trullatus. *Folia* caulis principalis ramorumque primorum similia, ea ramulorum ultimorum duorum generum; *folia caulis* 2.0 mm longa × 0.5–0.75 mm lata, oblongo-lanceolata, cellulis angustis hyalinis marginata, margine spinoso plerumque basin versus setoso, apicem versus denticulato; *folia media* 1.25–1.5 mm longa × 0.5 mm lata, lanceolata, auriculis acutis parvis, margine basi setoso rigido, supra acute dentato; *folia lateralia* ramulorum ultimorum foliis caulis similia. *Strobili* plus minusve simul maturescentes, apice ramulorum ultimorum positi, basis porophyllo femineo solitario, tum sporophyllis masculis tribus quatuoribusve postremo in parte supera foliis pluribus sterilibus munita. *Sporophylla feminea* 1.75–2.0 mm longa × 1.0 mm lata, late ovata, acuminata, marginibus basi integris, medio longe setosis, apice serratis; *sporophylla mascula* 1.75 mm longa × 0.75 mm lata, ovato-lanceolata, plus minusve acuminata, marginibus praeter basim integram sparse setosis. *Megasporae* 375–425 μ diam., lophatae, cristis tribus indistinctis; *microsporae* 35–38 μ diam., triletae, gemmatae vel mammillatae.

TYPUS: Zambia, Kawambwa District, Kawambwa, Timnatushi Falls, in wet white sand, 1260 m alt., 19 April 1957. *H. M. Richards 9325.* Holotypus **BM,** isotypus **K.**

An erect plant, 9–15 cm high, producing rhizophores at the base or from the axils of the lowest branches only. Lower primary *branches* of the first order up to 3 cm long, once or twice forked, upper branches gradually diminishing to those of second order, ultimate branchlets 3 mm long; outline of branch system when flattened commonly lanceolate or narrowly trullate. Leaves of the main stem and primary branches similar, those of the ultimate branchlets of two kinds; *stem leaves* 2.0 × 0.5–0.75 mm, oblong-lanceolate, bordered with narrow hyaline cells, margins spinose or usually setose towards base, denticulate towards apex; *median leaves* 1.25–1.5 × 0.5 mm, lanceolate with small pointed auricles, margins stiffly setose below, acutely dentate above; *lateral leaves* of ultimate branchlets similar to stem leaves. *Strobili* borne at the tips of ultimate branchlets, maturing ± simultaneously, with a single ♀ sporophyll at the base and with 3–4 ♂ sporophylls and

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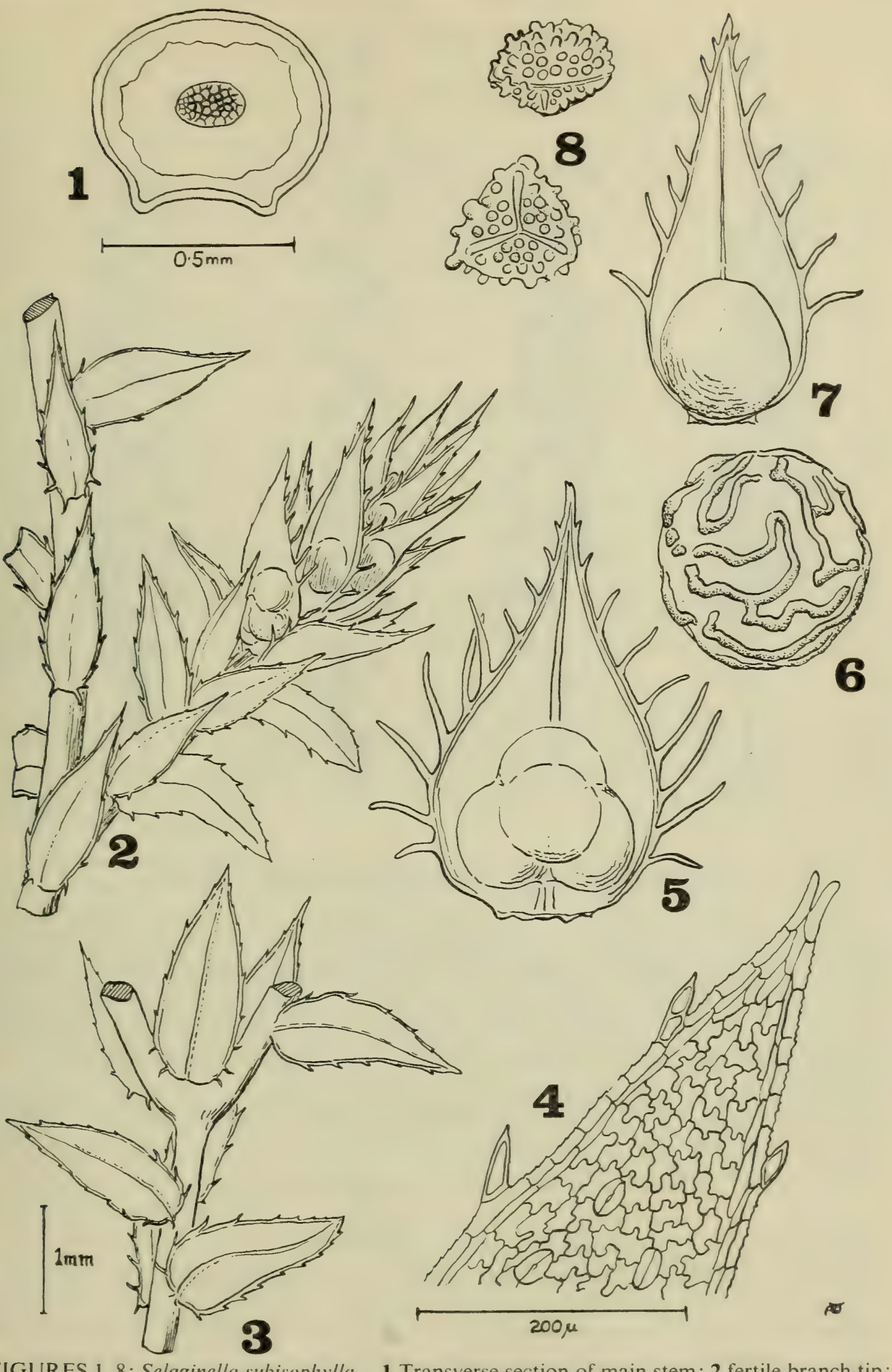
[1] Flora Zambesiaca, Pteridophyta. Ed. Exell, A. W. & Launert, E.



FIGURES 1–8: *Selaginella subisophylla.* **1** Transverse section of main stem; **2** fertile branch tip; **3** leaves of secondary branch; **4** enlarged portion of median leaf; **5** ♀ sporophyll; **6** megaspore; **7** ♂ sporophyll; **8** microspores.

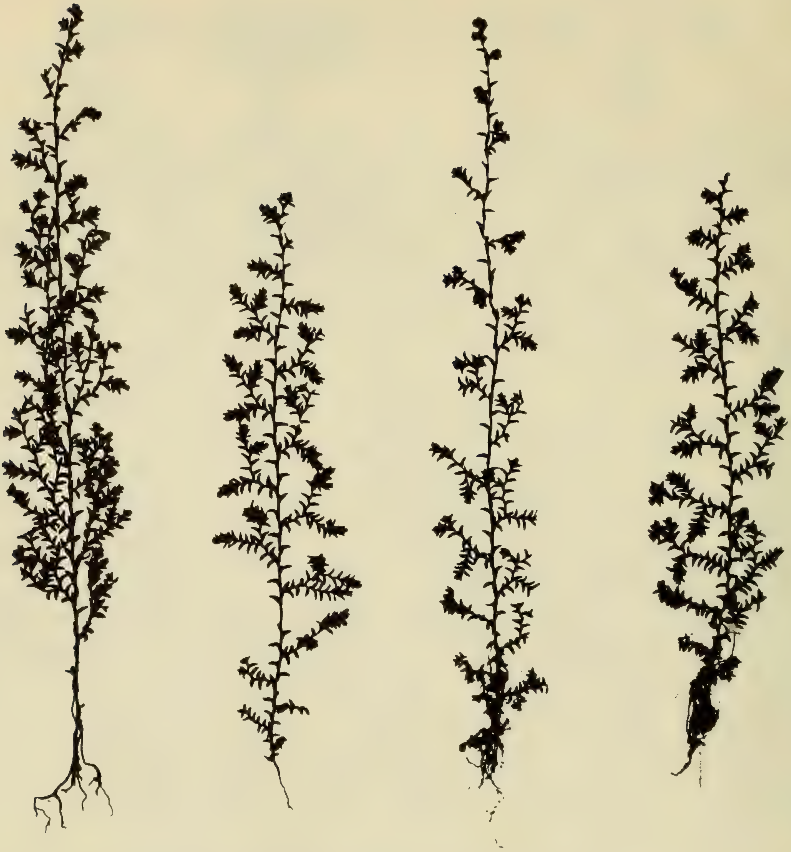


FIGURE 9: Silhouettes of *Selaginella subisophylla* (life size).

several sterile leaves above it. *Female sporophylls* 1.75 — 2.0 × 1.0 mm, broadly ovate, acuminate, margins entire at base, long-setose in the middle becoming serrate towards the apex; *male sporophylls* 1.75 × 0.75 mm, ovate-lanceolate, ± accuminate, margins sparsely setose except at base. *Megaspores* 375–425 μ, lophate, triradiate ridges indistinct; *microspores* 35–38 μ, trilete, gemmate or mammillate.

I should like to thank Dr W. T. Stearn for his help with the latin description.

NOTES AND NEWS

OBSERVATIONS ON TWO SPANISH FERNS

Thelypteris palustris **Schott.** The Marsh Fern is widely distributed throughout most of Europe, and *Flora Europaea* (1964) excludes "Spain and the extreme north" in the distribution. There are, however, at least two patches of it growing here in south west Spain, and I understand from Spanish botanists that it has also been found in the north of the country.

The main colony I found is in the San Roque district of the Cadiz province. It is at 170m in altitude, on an open sloping meadow, where the black muddy ground fringes a small copse of *Populus alba* L. About two to three metres beyond the trees is a large rocky ridge which runs down the hill to a river some 100m below. On the opposite side the rocks are continued in a huge massif called the Alcadeza Crags, which means that the meadow gets the intense heat thrown off from the more or less bare rocks in the summer. The marsh then becomes hard baked ground, except for a small part protected by a rock that is partly underground. This certainly stops the water from seeping downhill so rapidly, and it was here that the Marsh Fern was thickest. The patch of fern was about 1m wide by 2m long with a little more forming an arm at right angles. Fronds were bright green and erect, and on the 3rd May a few were newly fertile, but on June 14th, although the fertile fronds were still in the minority, the sporangia were dark in the mature sori.

Examining the pinnae under the binocular microscope in May, I found occasional yellow glands on the undersurfaces and from this concluded that it could not be *T. palustris*. In June I could not find the glands except on the indusia which is usual for the Marsh Fern; Mr Jermy kindly examined a specimen and agreed it must be *T. palustris*.

Mentha rotundifolia was woven in amongst the fern, and growing with it were *Cyperus longus*, *Holoschoenus vulgaris*, *Dorycnium* sp., *Samolus valerandii*, a blue-flowered *Myosotis* sp., *Lythrum* sp. and in pools made by the feet of cattle, were a small form of *Apium nodiflorum*, Water-cress and a Duckweed. On the previous April I had collected *Silene laeta* all over this wet area, but there was no sign of the fern then, although the sun is always hot at that time of the year. It had been an extremely dry winter, so perhaps was retarded.

In August I found another small patch of this fern growing on the edge of a small lake which was actually the still water of the River Cañas in the Los Barrios district of Cadiz province. Although the fronds were large, it was sterile and nearly submerged, although the river was probably at its very lowest. Nothing was growing near, and on one side was a large vertical rock and the only approach to the fern was by water.

Actually *Thelypteris palustris* was recorded by Wolley-Dod in Fl. Gibraltar (1914) [as *Polystichum thelypteris* (L.) Roth] and he says it was locally frequent in streams and marshes in the San Roque district. As he collected a great deal on the Alcadeza Crags, the first patch I found may have been one of those he recorded.

I think there is no doubt that this fern has always been here in SW Spain, and this citing by Wolley-Dod was inadvertently omitted from *Flora Europaea*.

***Equisetum* × *moorei* Newman.** This hybrid grows in brackish sand in amongst other growth at the mouth of Palmones River, near Algeciras (Cadiz province). It is not common and has not yet been found with cones so far as I know. Plants were growing within two metres of the normal water's edge, where there is a slight tide. In August I found this same horsetail was very common in one area which was a large sandy spit in an elbow of the upper Cañas River (about a mile or so above the Marsh Fern v.s.). It was surrounded by tall cliffs and of course there was no sea influence here as it is, I should think, about 8 miles from the coast. However, this river joins the Palmones nearer the sea, and so in fact they were both on the edge of the same river.

In neither place was any other species seen, but *E. telmateia* is common in shaded places on the riverbanks throughout the Los Barrios district.

Wolley-Dod (*op. cit.*) cites "*E. ramosum* Schl. Dry sandy places and cornfields, very common . . . this is doubtless the species referred to by Kelaart (Fl. p. 187) as *E. hyemale*." In brackets he elucidates: "*E. hyemale* L. Sandy banks; very local or error; . . . Abundantly by a tributary of the Guadarranque, Kelaart. Probably the Lajo is meant, where the last species is abundant." The Guadarranque river runs parallel to the Palmones, and these are about a mile or two apart. It is possible that the *Equisetum* they both referred to was *E.* × *moorei*, for I do not think *E. hyemale* grows anywhere near this area.

B. MOLESWORTH ALLEN

PTERIDIUM AQUILINUM ON LIMESTONE

During the Flora Europaea Symposium held in Sevilla in May 1967, Professor Askell Löve spoke about some *Pteridium aquilinum* (sensu lato) which he and Dr Ebbe Kjellquist had found growing on limestone at about 1350m in the mountains near Cazorla, in Andalucia, southern Spain. These plants had only half the chromosome number (2n = 52) of the widespread form which is normally a calcifuge, and he believed that it was not uncommon in southern Spain in calcareous soils.

Pteridium aquilinum is certainly very common in this south west corner, and from late spring to autumn forms the main floor-covering of the corkwoods here, from about 100m in altitude, although Valentine in *Flora Europea* considers it occurs mainly in the mountains in southern Europe. It is also very common from the foothills to the summits of the adjacent hills, where in most areas the usual lime-hating heathers of various species form an important part of the floor-covering. Bracken normally dies back about October–November, but when in very sheltered places, fronds survive the winter.

Limestone is not apparent in the areas where *Pteridium* is so common, but just below San Roque there is a calcareous shelf, most of which is covered with shallow soil (and there are no heathers here). A small quantity of bracken occurs on the sloping face immediately below the shelf where there are small out-crops of limestone appearing through the soil. So far, the cytology of this population has not been studied. Wolley-Dod[1] found "a starved plant or two growing through the concrete of a water chute" on Gibraltar, which is limestone; I must confess that I have not looked to see whether it still exists on The Rock.

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[1] Wolley-Dod, A. H. 1914. A flora of Gibraltar and the neighbourhood. *J. Bot. Lond.* **52**, *Suppl.*: 124.

Dr Löve has certainly stimulated my interest in this bracken problem, and he feels that the two forms are not identical because of their morphological differences. I am grateful to him for his help and for allowing me to use freely all the information which he so kindly and willingly gave to me.

Following this, I feel it would be interesting to investigate the Malayan brackens in the same way. Two species occur there: *P. aquilinum* (L.) Kuhn and *P. caudatum* (L.) Maxon [called *P. esculentum* (Forst.) Diels in Holttum[2]].

Henderson[3] states that *Pteridium* had not been recorded as occurring on Malayan limestone, but goes on to say that Steenis[4] records it on steep limestone hills in central east Borneo, amongst the early colonisers on cleared areas caused by spontaneous fires. In Malaya, in the Kinta Valley of Perak, there are many tall limestone outcrops. On several of these I found that *P. caudatum* was common in patches where the vegetation had been removed by clearing and burning. This species which does not die back here, was always one of the first colonisers, together with *Nephrolepis* spp. (a genus which van Steenis also mentioned) and an enormous aroid, *Colocasia gigantea* Hook. f.

Now as Henderson says "collecting on the limestone in Perak has been more extensive than in any other State". He himself visited many of these, and I am sure that had the bracken been there in the 1930's it would have been noted by that astute botanist. Therefore it is reasonable to suggest that it is a fairly recent arrival on the outcrops. It has long been known from the neighbouring non-calcareous hills, and on the outskirts of the remaining lowland forests in the Valley. So it would be interesting to find out if the cytology differs between specimens from the two distinct habitats. *P. aquilinum* in Malaya has the same chromosome number as its European relative, but so far as I know, that of *P. caudatum* has not been studied.

Normally *P. aquilinum* is a common mountain fern in Malaya and *P. caudatum* is common in the lowlands, although they have been found growing together in Singapore at a low altitude. The latter has now begun to appear in the mountains at about 1350m in cleared areas of some of the hill stations. In 1960, at Fraser's Hill in Pahang, I found some which appeared to have characters of both species. I did collect these, but alas, was not then interested in their cytology. It does appear however, that the more open spaces there are, the more common bracken becomes. Yet it was always surprising to me how often either species was absent over wide areas in Malaya. Of course *Gleichenia* spp. with their surface-rhizomes, grew rapidly over barren and cleared ground, and formed dense thickets especially on forest outskirts, and may not have given bracken its normal chance. *Gleichenia*, in fact was often called "bracken" by British planters, for it behaved in much the same way.

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[2] Holttum, R. E. 1954. *A revised flora of Malaya*, Singapore **2**: 389–390.

[3] Henderson, M. R. 1939. The flora of the limestone hills of the Malay Peninsula. *J. Malay. Brch. R. Asiat. Soc.* **17**: 18.

[4] Steenis, C. G. G. J. van 1935. Maleische vegetatieschetsen I. Toelichting bij de Plantengeografische Kaart van Nederlandsch Oost Indie. *Tijds. K. Nederl. Aardr. Gen.* ser. 2, **52**: 48.

A note about the nomenclature of the Malayan taxa: Tryon[5] keeps *Pteridium* to one species, *P. aquilinum* (L.) Kuhn with two subspecies: *typicum* and *caudatum*. Holttum[6] prefers to regard them as varieties of separate species: *P. aquilinum* var. *wightianum* (Ag.) Tryon and *P. caudatum* var. *yarrabense* Domin; the distribution of the former ranges from western Himalayas to S China and southwards through Malaysia to SE New Guinea, etc., whilst the latter is found in N Queensland, Malaysia, parts of Thailand and Indochina.

B. MOLESWORTH ALLEN

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[5] Tryon, R. M. 1941. A revision of the genus Pteridium. *Rhodora* **43:** 1–31, 37–67.

[6] Holttum, R. E. 1961. Pteridium in Malaya. *Malay. Nature J.* **15:** 75.

OUR NAMELESS CULTIVARS

In the course of revising the National Museum of Wales publication 'Welsh Ferns', I was faced with the problem of finding the correct botanical name for the Welsh Polypody. This fern was first recorded by John Ray, in his Synopsis Stirpium Britannicarum, ed. 1, 22, 1690, as growing 'On a rock in a wood near Dennys Powis Castle, not far from Cardiff in Glamorganshire, Wales'. According to Hyde and Wade (1962)[1] it appears to have become extinct at Dinas Powis Castle early this century. Ray called the Welsh Polypody '*Polypodium cambro-britannicum*', but this name can be ignored because it pre-dates the Species Plantarum, ed. 1, 1753, which is the starting point for pteridophyte nomenclature. In this work, Linnaeus used the name '*Polypodium cambricum*', with the following description—'Polypodium frondibus pinnatifidis: pinnis lanceolatis lacero-pinnatifidis serratis'. He gives the fern's habitat as 'In Anglia', but despite this error and the difference in name, there is no doubt that he was referring to the same plant, for he cited Ray and also a specimen in the Hortus Cliffortianus in London (BM).

Since the time of Linnaeus, Lightfoot and most later authors have regarded the Welsh Polypody as a variety of the Common Polypody, i.e. *Polypodium vulgare* var. *cambricum* (L.) Lightfoot. However, according to Shivas (1961)[2], it is undoubtedly diploid, although further investigation is precluded by the complete absence of sporangia. It seems reasonable to regard it as a sterile monstrous form or cultivar of the diploid species *Polypodium australe* Fée (*P. vulgare* L. subsp. *serrulatum* Arcangeli). It resembles this taxon (and differs from *P. vulgare* L. emend Shivas) in the shape and proportions of its fronds and pinnae. Fertile specimens of *P. australe* frequently exhibit some degree of lobing of the pinnae, less complete than in the Welsh Polypody, but resembling it, and showing a similar trend.

Having decided that the Welsh Polypody should be placed under *P. australe*, it was necessary to determine its rank. In the Welsh National Herbarium, there are several specimens which apparently have been collected in the wild (in Glamorgan, Cardiganshire, Caernarvonshire and Denbighshire) and fewer which definitely were cultivated. But the Welsh Polypody entered commerce at an early date and is well known to fern-growers as well as to field pteridologists.

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[1] Hyde, H. A. & Wade, A. E. 1962. Welsh Ferns, 4th ed. Cardiff.

[2] Shivas, M. G. 1961. J. Linn. Soc. Lond. (Bot.) **58:** 28.

So, should it be classed as a cultivar, or as an infraspecific botanical taxon?

I'm afraid that the answer may be neither, and this same answer may apply to many other ferns which are monstrous forms known to have been brought into cultivation from the wild.

According to Article 71 of the International Code of Botanical Nomenclature (1966) "A name must be rejected if it is based on a monstrosity."

This Article is obviously intended to apply to botanical ranks, e.g. species and varieties, but there is no clause in the Code to permit exceptions being made in the case of cultivars. Nor is there a clause specifying that the term 'name' in the Code refers only to botanical binomials and trinomials, that is, to botanical species and varieties, and not to cultivars. Many—perhaps the majority—of fern cultivars must be considered to be monstrosities, however beautiful they may be. In order to save many of our garden ferns from the stigma of illegitimacy, it would seem necessary to propose a modification of Article 71. I suggest that the existing passage should be changed to:—"A name must be rejected if it is based on a monstrosity, with the exception of cultivar names, including those of cultivars formerly given a botanical rank."

I make this proposal in order to justify the continued use of the name *Polypodium australe* **'Cambricum'** for the Welsh Polypody and also to safeguard the names of many other cultivars, whether ferns or other plants, which are scorned or treasured as 'monstrosities'.

S. G. HARRISON

ASPLENIUM ADIANTUM-NIGRUM × *SEPTENTRIONALE* :

A HYBRID NEW TO BRITAIN

Dr J. D. Lovis and Prof. T. Reichstein are convinced that the fronds widely distributed as *Asplenium* "*germanicum*" in the 1870s by the Rev. T. Butler, from a plant collected by him in the Pass of Llanberis whose identity has always been uncertain (see Rep. Bot. Soc. Exch. Cl. Brit. Is. 1880: 38; 1881: 59), in fact represent *Asplenium adiantum-nigrum* × *septentrionale*. Such a hybrid has not previously been recorded from the British Isles. A more detailed report will appear in a future issue of this journal.

PTERIDOPHYTE SURVEY OF FLORES

A preliminary report of the Chelsea College Azores Expedition 1967

About 32 species of ferns were found growing wild. Of these only one is endemic to the Azores and another to the Atlantic Islands, 21 are also found in Britain and three in other parts of Europe. Six species are not found elsewhere in Europe apart from the Azores, originating in tropical American or Africa. Five species found have not previously been recorded for Flores including *Thelypteris limbo-*

sperma which has not previously been recorded for the Azores. Pressed specimens were collected for the British Museum (Natural History) and living specimens were sent back for cultivation at Chelsea Physic Garden.

Broadly the Island consists of four habitats:

(i) **The coastal ravines.** An example of this habitat is the ravine of Ribiera da Cruz near Santa Cruz. *Equisetum telmateia* grows in the loose boulder deposits almost to the high tide mark but better specimens occurred in waterlogged soil higher up the stream. On the steep sides of the valley *Woodwardia radicans* grows thickly. This fern also forms the herb layer of the wooded slopes with *Pteridium aquilinum*. *Athyrium filix-femina* also grows in the woods and in the shade of Hydrangea bushes. *Selaginella kraussiana* grows in mats on the soil and rock surfaces. Where the ravine narrows inland and is overhung by trees *Osmunda regalis* was found.

(ii) **The central plateau.** The fern vegetation of this area which comprises a large part of the island is generally constant. *Pteridium aquilinum* is usually dominant but *Blechnum spicant* is also common with *Athyrium filix-femina* and *Dryopteris aemula*. Single plants of *Polystichum setiferum* occur well scattered. On the sides of drainage channels *Pteris serrulata* is common. *Huperzia* (*Lycopodium*) *selago* grows through the dense moss layer.

(iii) **The Cauldieras.** In general these have a very similar fern flora, but that of the steep sided craters is more varied than that of the shallow ones whose composition varies little from that of the central plateau. Generally *Woodwardia radicans* and *Osmunda regalis* inhabit the cliff faces and *Athyrium filix-femina*, *Dryopteris aemula* and *Blechnum spicant* the slopes. *Selaginella kraussiana* grows amongst the grass of the pasture. *Isoetes azorica* grows in two of the shallow lakes.

(iv) **The Fajanzina Valley.** This is an area of dense damp woodland between Fajanzina and Faja Grande. *Diplazium caudatum* and *Pteris serrulata* dominate the herb layer. *Trichomanes speciosum* grows thickly on the boles of trees and on rocks.

COLIN M. WARD

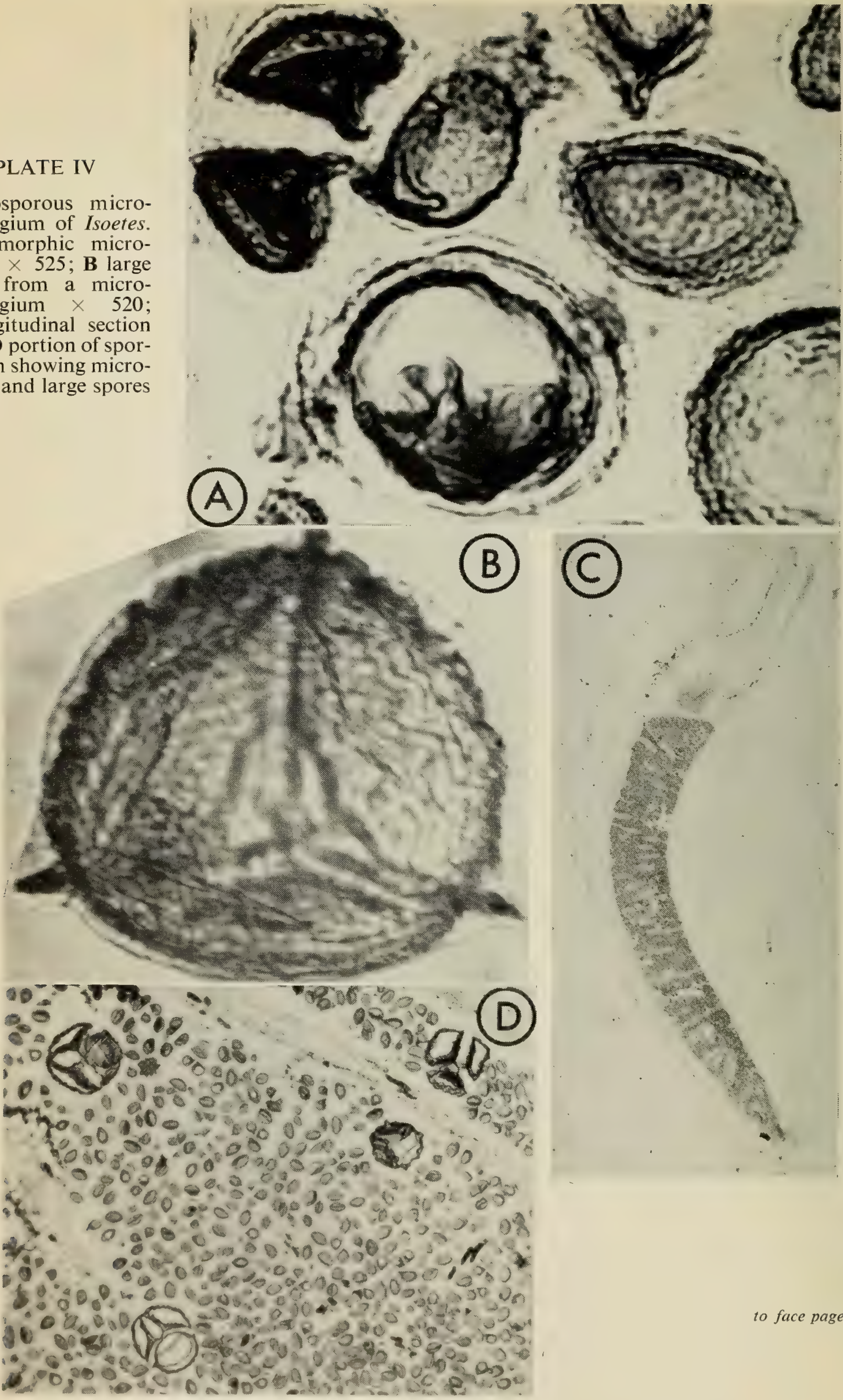
ONOCLEOPSIS: REVISITED

The monotypic fern genus *Onocleopsis* of aspidioid affinities was described by F. BALLARD of Kew (1945, 1948)[1] from specimens sent to him by G. B. Hinton from Los Hornos, Mexico. Unknown to Ballard at that time were the earlier collections of this rare fern by C. G. Pringle in 1896 (above Cuernavaca) and Conzatti and González in 1898 (Cerro San Felipe, Oaxaca). Steyermark also collected it on the north-western slopes of Volcan Tajumulco in Guatemala in 1940. Since 1943, the date of the last Hinton collection, *Onocleopsis* has evidently remained hidden from the most intrepid of the botanical explorers and data on its biology has been largely lacking.

During November 1966, W. R. Anderson and C. W. Laskowski of the University of Michigan rediscovered *Onocleopsis* in three new locations in southern Mexico (3.9 and 7 miles south of Suchixtepec, at K132 south of Oaxaca on the road to Puerto Angel; 17.5 miles north-east of Teotitlán del Camino, south-east of Tehuacan, on the road to Huatla de Jiménez, Oaxaca; and near the village of

PLATE IV

Heterosporous microsporangium of *Isoetes*. **A** Trimorphic microspores × 525; **B** large spore from a microsporangium × 520; **C** longitudinal section × 6; **D** portion of sporangium showing microspores and large spores × 60.



Omiltemi, about 20 miles west of Chilpancingo, Guerrero). These new collections reveal that *Onocleopsis* is much more widely distributed than once thought and is in little danger of extinction. The species does appear, however, to be relatively narrowly restricted in habitat, having been found only in muddy soil, in moderate to deep shade along streams at the base of pine–oak clad slopes between the elevations of 2000 and 2550 metres.

Like *Blechnum werckleanum* C. Chr. and *B. buchtienii* Rosenst. of the "paramo" bogs of Costa Rica, *Onocleopsis* is a 'tree-fern' with an erect rhizome up to ½ metre tall. However, its overall morphological features indicate a close affinity with the temperate genera *Onoclea* and *Matteuccia*.

Living material is now in cultivation at the botanical gardens of the University of California and the University of Mexico.

University of California ROBERT M. LLOYD

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[1] BALLARD, F. 1945. A new fern genus from Mexico and Guatemala. *Amer. Fern J.* **35**: 1–3.
—— 1948. Further notes on Onocleopsis. *Amer. Fern J.* **38**: 125–132.

HETEROSPOROUS SPORANGIA IN *ISOETES*

As far as we know the occurrence of male and female spores within the same sporangium is unknown in any living plant. Even among fossils, mega- and microspores have been described in one sporangium only in *Calamostachys americana*[1] but PETTITT[2] suggests that this may be due to the plane of cutting. In the tetrads of megaspores in *Stauropteris burntislandica*, CHALONER[3] discussed the possibility of the sporangia containing both kinds of spores but cautiously rejected it. SHATTUCK[4] found two sizes of spores in abortive microsporangia of *Marsilea*.

The plants of *Isoetes* described in the present note are, therefore, of outstanding interest because they show inside their microsporangia as well as microspores, large spores which can sometimes reach a size which is beyond the generally accepted range of microspores (200 μ). We have found these large spores invariably present towards the ligular side of more than 50 microsporangia taken out at random from different plants. Their frequency in microsporangia has been determined to be 6 per 10,000 microspores. The form of these large spores (? megaspores) is similar to that of the smaller megaspores occurring inside the megasporangia (see table below):

	Microspores	*Large spores in microsporangium*	*Megaspores*
Diameter	15–54 μ	98–200 μ	70–110; 280–312; 450–600 μ
Laesurae	Alete, monolete or trilete	Trilete	Trilete
Surface sculpture	Smooth or papillose	Tuberculate, tubercles round or pointed	Tuberculate, tubercles round

[1] ARNOLD, C. A. 1958. *Contr. Mus. Paleont.* Univ. Mich. **14** (10): 149–166.
[2] PETTITT, J. 196–. *Bull. Brit. Mus. Nat. Hist. Geol.* **10**: 83–92.
[3] CHALONER, W. G. 1958. *Ann. Bot.* **22**: 197–204.
[4] SHATTUCK, C. H. 1910. *Bot. Gaz.*, Chicago. **49**: 19–40.

In view of the occurrence of this unique and constant feature in this form of *Isoetes* (plate IV), we are making a detailed study of these plants and trying to confirm the nature of these large spores.

Other interesting features of this form include a typically tilted growth of the corm which shows 3 lobes, out of which 2 are larger than the third. The megasporangia are circular to broadly oval, the microsporangia are narrower, ovate to oblong. The megaspores, as well as the microspores (not including the large spores referred to above) are trimorphic, distinguishable into three sizes. All megaspores are trilete showing round tubercles on their surface. The large and medium sized megaspores are 450–600 μ and 280–312 μ in diam., respectively. Both these kinds have a four-layered wall, their commissural ridges are straight, whereas the smaller megaspores are 70–110 μ in diam, with a three-layered wall and sinous commissural ridges. The megasporangia show a high frequency of joined megaspores, their ratio being 5:1. All microspores are ash-coloured, between 15 to 54 μ in diam. and their walls show a uniform perispore, thick exospore, and a thin hyaline endospore. Large microspores are alete and show a smooth surface; medium sized microspores are oval and monolete, and small microspores are trilete and papillose.

The only Indian species of the genus with which this form may be compared is *I. indica*[5], which has the same number of lobes in rhizomorph, and polymorphic megaspores. However, it differs in its tilted growth, in having unequal lobes in rhizomorph; round tubercles in megaspores and above all in the invariable and the unique occurrence of megaspore-like large spores inside the microsporangia. A fuller description of the plants under study (which may belong to a new species) will be published later.

We are indebted to Professor D. D. Pant, Head of the Botany Department, Allahabad University for providing laboratory facilities to one of us (H.K.G.) and valuable guidance. Thanks are also due to Dr G. K. Srivastava for critical observation of the material, to Dr D. D. Nautiyal for kind encouragement and Mr A. C. Jermy for help with references.

H. K. GOSWAMI & B. S. ARYA

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[5] PANT, D. D. & SRIVASTAVA, G. K. 1962. *Proc. Nat. Sci. Inst.* **28** B: 242–280.

BRITISH FERN VARIETIES IN CULTIVATION TODAY. I

As a stimulus to other gardeners to document their holdings of fern varieties in cultivation at the present time I have listed the 202 varieties I have in my garden at Alrewas, near Burton-on-Trent. I have studied and compared these forms for many years and firmly believe each to be different and worthy of a separate name. The Society would be keen to have further lists or notes on any other varieties in cultivation.

Asplenium trichomanes 'Cristatum'.
  viride 'Bifidum', 'Cristatum Dyer'.

Athyrium filix-femina 'Acrocladon', 'Alatum', 'Angusto-cruciatum', 'Cristatum', 'Capitatum Wollaston', 'Clarissima Bolton', 'Clarissima Jones', 'Congestum Cristatum', 'Congestum Grandiceps', 'Coronatum', 'Corymbiferum', 'Craigii Cristatum', 'Crispum', 'Crispum Coronatum', 'Cristatum', 'Cristulatum', 'Cruciatum Cristatum', 'Curtum', 'Curtum Cristatum', 'Depauperatum', 'Depauperatum Cristatum', 'Diadematum', 'Fieldiae', 'F.

Compositum', 'Fimbriatum Cristatum', 'Foliosum Grandiceps', 'Formoso-cristatum', 'Frizelliae', 'F. capitatum', 'F. Cristatum', 'F. Multifidum', 'F. nanum', 'F. Ramo-cristatum', 'Gemmatum Barnes', 'Gemmatum Bolton', 'Glomeratum', 'Grandiceps', 'Lineare', 'Minutissimum', 'Multifidum', 'Nudicaule', 'Nudicaule Cristatum', 'Obtusissimum', 'Plumosum', 'Plumosum Cristatum', 'P. Druery', 'P. Furcillans', 'P. Multifidum', 'P. Percristatum Dyer', 'P. Pericristatum Kaye', 'P. Rowlands', 'P. Stansfieldii', 'Pritchardii', 'Pulcherrimum', 'Ramo-cristatum', 'Setigerum', 'Subplumosum', 'Vernoniae', 'Victoriae', 'Victoriae Gracile', 'Unco-glomeratum'.

Blechnum spicant 'Furcans'.

Dryopteris abbreviata 'Crispa', 'Cristata'.
borreri 'Angustata Cristata', 'Crispa Cristata', 'Cristata', 'Cristata The King', 'Grandiceps Askew', 'Multicristata', 'Polydactyla Drouetii', 'P. Dadds', 'P. Stewardson', 'P. Wills', 'Ramosa Furcillans', 'Ramosissima Wright', 'Ramoulosissima', 'Revolvens', 'Stableri'.
filix-mas 'Acrocladon', 'Barnesii', 'Barnesii Crispa Cristata', 'Bollandiae', 'Crispa', 'Crispa Cristata', 'Crispatissima Grandiceps', 'Cristata', 'Cristata Martindale', 'Decomposita', 'Depauperata', 'Furcans', 'Gracilis Polydactyla', 'Grandiceps', 'Grandiceps Wills', 'Linearis', 'Linearis Congesta', 'L. Cristatum', 'L. Polydactyla', 'Polydactyla Dadds'.

Gymnocarpium dryopteris 'Plumosum'.

Osmunda regalis 'Cristata', 'Purpurascens'.

Phyllitis scolopendrium 'Acrocladon', 'Crispa', 'C. Cristata', 'C. Nobilis', 'C. Robert Whiteside', 'Cristata', 'Fimbriata', 'F. cristata', 'Grandiceps', 'Glomerata', 'Lacerata Kaye', 'Lacerata Healey', 'Marginata', 'M. Cristata', 'Muricata', 'Ramo-cristata', 'Ramo-marginata', 'Ramo-prolifera', 'Sagittato-cristata', 'Spiralis', 'Undulata'.

Polypodium vulgare 'Bifido-cristatum', 'Bifido-grandiceps', 'Caudatum', 'Cristatum' (old form), 'Cornubiense', 'C. Cristatum', 'C. Elegantissimum', 'C. Foliosum Clapham', 'C. Pumilum', 'Glomeratum', 'Grandiceps', 'G. Forsteri', 'G. Fox', 'Longicaudatum', 'Macrostachyon', 'Marginatum Inequale Varians', 'Multifidum', 'Plumosum Barrowii', 'P. Cambricum', 'P. Hadwinii', 'P. Prestonii', 'P. Whilharris', 'Pulcherrimum', 'Ramosum', 'Serratum'.

Polystichum aculeatum 'Acutilobum Dyce', 'Grandiceps Jones', 'Gracillimum', 'G. Cristulatum', 'Plumosum Green', 'Proliferum', 'Pulcherrimum Bevis', 'P. Stansfieldii' (three forms).
setiferum 'Acrocladon Whiteside', 'Acutilobum', 'A. Proliferum', 'Confluens', 'Congestum Grandiceps', 'Conspicuilobum', 'Cristatum Brookfield', 'Cruciato-pinnulum', 'Cristatum', 'C. Gracile Moly', 'Cristulatum', 'Cuneatum', 'C. Cristatum', 'Decompositum', 'Divisilobum acutum', 'D. Bland', 'D. Brookfield', 'D. Densum', 'D. Foliosum', 'D. Iveryanum', 'D. Nicholls', 'D. Plumosum', 'D. Plumosum Densum', 'D. Whiteside', 'D. Wynne', 'Foliosum', 'Grandiceps', 'Grandidens', 'Latipes', 'Lineare', 'Manica-infantis', 'Micron', 'Multilobum', 'Plumoso-divisilobum', 'Plumosum Grande Moly', 'Proliferum', 'Pulcherrimum Moly's Green', 'Ramo-cristatum', 'Thompsoniae', 'Tripinnatum', 'Wakeleyanum'.

THEO A. DYER

THE BPS EXCURSION TO KETTLEWELL

J. W. DYCE

The Yorkshire hills and dales with their limestone scars and pavements nurture some of Britain's finest and rarest plants. It is not an area 'dripping with ferns', but 30 species can be found, some of them rare, and very few of them growing in abundance in any locality. Not only botanically but geologically, this part of the country is of the greatest interest with its Carboniferous limestone formations, and bounded on the south by the great Craven Faults, well shown by the sudden transition from bare mountain scenery to flat wooded and cultivated lands. The Giggleswick Scar near Settle is an excellent example of this deep drop from mountain to arable plain. The fern-hunter seems to have left the area severely alone and conceded it to the general botanist and the searcher for alpine flowering plants. Reginald Farrer lived here, and knew well the rarities of Ingleborough, Penyghent and the other high hills, with their long narrow deep dales. He waxes eloquent in condemnation of the plant vandal, and tells how that loveliest of all British plants, *Cypripedium calceolus*, the Slipper Orchid, was practically wiped out by their depredations from this district which was once one of its chief centres. Where at one time it was abundant, it is now exceedingly rare, and its few remaining habitats are closely guarded secrets by those who have been fortunate enough to see it growing in the wild.

In this region the Society held its 1967 Annual Excursion, centred at Kettlewell in Wharfedale, from the 2nd to the 9th of September. Kettlewell is a small compact village tucked away in a corner of the dale and surrounded by high hills. Past it flows the River Wharfe and through it rushes the Park Hill Beck, enhancing the beauty of the old peaceful little town. No doubt it was an important meeting-place in the Dale in bygone days for it has three good hotels, one reason why we selected this centre with enough accommodation to absorb our party. In all, over the week or part of it, we had 35 members and friends.* Both horticulturalists and botanists were present, and we were particularly pleased to welcome from the U.S.A. Professor W. H. Wagner of the University of Michigan, Ann Arbor.

The weather to begin with was far from good with heavy rain which culminated in a terrific storm of wind and downpour on the Tuesday, flooding the roads and swelling the streams into raging torrents. Fortunately none of the roads on which we were travelling were impassable to cars, although it was with hesitation that we ventured into some of the waters. Past our hotel swept the Wharfe in spate, joined by the tumbling mill-race of the village beck, and we were reminded of our stormy stay at Breitlahner in the Austrian Tyrol in 1965. The rain-god must have put all his efforts into that day, and utterly exhausted, contented himself with a few scattered showers on Wednesday, and allowed us to have two fine sunny days on the Thursday and Friday—we made the most of them.

The Secretary arrived at Kettlewell a day early on the Friday, and accompanied by Miss V. L. Wood who was able to come for only one day, visited Ingleborough on the Saturday. At Chapel-le-Dale on the shoulder of the mountain, we were able to get on the limestone pavement after only a few minutes walk and found the grikes full of ferns and other plants. Limestone pavement is to be found in many places in the region and as its name implies, is a flat bare limestone formation extending over large areas of the mountain and intersected by deep narrow fissures formed over countless centuries by the action of water seeping into the vertical joints of the stone and gradually dissolving it away. These crevices known as grikes, vary from a few inches to about two feet wide and up to ten or twelve feet deep, and provide shelter and growing conditions, in an otherwise inhospitable habitat, for a multitude of plants, among them some of our rarest ferns and flowers.

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*Mrs E. M. Brightman, H. J. Bruty, L. Burnett, J. Cartwright, R. F. Cartwright, J. A. Crabbe, Dr J. Davidson, J. W. Dyce, Mrs E. M. Dyer, T. A. Dyer, S. G. Harrison, Mrs C. E. U. Holttum, Dr R. E. Holttum, Dr F. M. Jarrett, Mrs A. Jermy, A. C. Jermy, Mrs M. Kaye, R. Kaye, Mrs Lovis, Dr J. D. Lovis, Miss H. D. M. Norman, R. S. W. Pollard, Rev. C. E. Shaw, Mrs P. Simmonds, Mrs Sledge, Dr W. A. Sledge, P. Temple, Miss M. I. Tetley, Mrs B. J. Tingey, F. J. Tingey, Professor W. H. Wagner, Miss V. L. Wood, A. J. Worland, W. Wright, and M. J. Young.

The party visited the same place on Monday, but drenched by heavy rain driven by high winds across the exposed pavement high on the mountain side, we retreated to the cars. After a damp lunch only a few of us stayed on to explore the pavement further, while the others retired to the shelter of the lower valleys. But the weather improved and allowed us to enjoy the sight of many interesting ferns growing luxuriantly in their unusual homes. The limestone species were of course in their element, and *Asplenium ruta-muraria*, *A. trichomanes*, and *A. viride* were abundant. In particular *A. viride* revelled in the conditions. Equally widespread was *Cystopteris fragilis* and the two rarer ferns, *Gymnocarpium robertianum* and *Dryopteris villarii*, also *Polypodium vulgare*. A predominant feature of limestone grike habitats is the lush growth of *Phyllitis scolopendrium* in even greater abundance than the other ferns, and many magnificent specimens attracted our admiring attention. Another common fern growing strongly, with handsome glossy fronds was *Polystichum aculeatum*, and one would have expected to see its rare relative, *P. lonchitis*, particularly as it was found in some abundance in similar conditions on the other side of the mountain later in the week, but it did not appear to be there.

The members deterred by the inhospitable weather conditions on Ingleborough scattered in different directions. Some explored the Kingsdale Beck north of Ingleton, others hunted the Feizor area near Austwick and a few returned to Kettlewell and scrambled up the scars to the west of the village. Only nine species were noted in Kingsdale, chiefly the large-growing wood ferns. The Feizor party hunting on the higher ground between Pot Scar and Shake Hole found the smaller limestone ferns predominating, and the records from the Middlesmoor Pasture scars above Kettlewell on the west were similar. At Pot Scar, in addition to eleven species, a colony of *Asplenium viride* 'Bifidum' was found.

In Kettlewell village with its many stone walls, the wall species were abundant, *A. ruta-muraria*, *A. trichomanes*, *C. fragilis*, *P. scolopendrium*, *P. vulgare* (aggregate), and along the banks of the beck, *D. filix-mas*. One magnificent large colony of *C. fragilis* along the foot of a wall by the roadside was a fine sight. Hunting at Park Rash up the side valley from the village, added *A. viride* and *P. aculeatum* to the above records. The scars above Scar Hill House on the east side of the Dale near Kettlewell, were the first objective of our party on the Sunday morning following our arrival, and here we had a good introduction to the limestone ferns of the area. *A. ruta-muraria*, *A. trichomanes*, *A. viride*, *C. fragilis*, *P. scolopendrium* and *P. vulgare* were common, growing in cliff crevices and among the mass of fallen boulders which filled a shallow ravine. Some *Gymnocarpium robertianum* was also seen and in the woods below the scars some of the larger ferns were common. In the afternoon we travelled down the Dale to Grass Wood south of Conistone, where woodland species were again growing in large numbers.

Very little hunting was done on the Tuesday although we were out in the field, but confined for most of the time to the cars in a small closed-in valley near Stalling Busk, watching the rain lashing down. We had dropped a few of the younger members near Oughtershaw on the Hawes road and they walked over the hills, exploring Jeffery Pot a cirque of loose limestone cliffs on the hillside, on their way to join us in the valley. In spite of weather conditions they noted that Jeffery Pot was festooned with many plants, including the ferns *A. viride* and *C. fragilis*, and could be well worth exploring at leisure. Lower in the valley they found lush-growing larger species, and passed through an interesting wood with *Athyrium filix-femina* and *D. dilatata* epiphytic on old alder trees. It is considered that this wood should be scheduled by the Nature Conservancy as an area of special interest. The whole of this small valley, Raydale, in which several large becks meet to feed Semer Water, seemed from the map to be most interesting, and our visit confirmed this although we were unable to see the place properly. Even so, in hurried sallies during momentary lulls in the storm, various members compiled a list of eleven fern species.

Wednesday was what we termed a 'free day' which allowed members to make their own plans, to go shopping in Skipton and visit places of interest such as Bolton Abbey and Fountains Abbey. Ferns were not ignored however, and records were kept of those seen. A reduced party which kept 'on the job' travelled south off the hills through Threshfield and Cracoe to Gargrave, hunting at various places en route along the roadsides and on walls. We were hoping to find *Ceterach officinarum*, but did not see it and other ferns were not in great numbers. One interesting find was a hybrid polypody between *P. interjectum* and *P. vulgare*. Turning north again we continued our hunting at stops on our road which led us through Malham and on to Gordale Scar. Unfortunately the Gordale Beck was still in flood after the rains of the previous day, and we were unable to get up past the waterfalls into the Gorge which is a mile long. Very few ferns were noted on the cliffs below the waterfall and in the Wedber Wood through which the beck flows lower down below Gordale Bridge. A quick look through the Malham Tarn Woods on our way back was also productive of very little.

On Thursday and Friday we were joined by Dr J. D. Lovis and Dr W. A. Sledge from Leeds University who are familiar with the district, and on Thursday they led the party on Moughton Fell. We climbed in lovely weather from Horton-in-Ribblesdale railway station over patches of thin limestone pavement with many ferns growing in the shallow grikes. On this day we recorded sixteen fern species, including all the, by now, familiar inhabitants of the grikes and also several *Dryopteris* species, but the find of the day was the rare *Polystichum lonchitis*, growing in moderate abundance. An unusual find was *Blechnum spicant*, a fern we saw very little of during the week for it is a well-known lime-hater. It was therefore of interest to find it on this limestone fell, but as often happens in this type of habitat, there are peaty hollows from which all the lime has been leached, and in one of these the fern was plentiful. More unusual was the fact that some plants of the variety 'Anomalum' were found, with no fertile fronds but sporing heavily on some of the normally barren fronds. An unconfirmed record for

Asplenium septentrionale from further up Ribblesdale induced some of us to go in search of it after our descent from Moughton Fell. We did not find it, but our hunting led us into some old railway workings cut out of the rock. This proved to be a most rewarding place with many ferns on the rock walls and floor of the workings. A flourishing colony of *Ophioglossum vulgatum* was found, and this attracted several members who had not previously seen this fern in the wild, to the place on the following day. Many other interesting plants as well as ferns were found, and also a flourishing specimen of *Dryopteris filix-mas* 'Grandiceps'.

The Austwick area was chosen for our final day. Again led by Dr Lovis and Dr Sledge on a fine warm day, we set off from Austwick village along a lane running northwards, and turning downhill across a stream, returned along the valley below the Moughton Fell scars to the hamlet of Wharfe. The larger ferns were common in the lanes, including some which were identified as *Dryopteris filix-mas* × *D. borreri*, and small ferns were frequent on the walls. In the afternoon we climbed to Wharfe Wood, and among the many ferns seen were *Gymnocarpium dryopteris* and *Thelypteris phegopteris*. We also found *Selaginella selaginoides* on a boggy slope, and in the same place, growing in a very unusual habitat, was *Lycopodium selago*. Higher up there were patches of pavement with their usual pteridophytic inhabitants, and on some grass slopes where it had been seen earlier in the year, we hunted for *Botrychium lunaria*, but the fronds must have been eaten by browsing animals and it was not visible. June is probably the best month to search for the Moonwort which is recorded from many localities in the region. Before returning to Kettlewell, some of the party visited the first-rate collection of fern varieties grown by Mr Lord in his garden in Austwick, and among them were some excellently grown unique plants which were admired enviously by the growers among us. This visit made a pleasant close to the Excursion.

The evenings were spent chatting, preserving specimens and discussing field activities, and several exhibits of colour slides were enjoyed. After the Annual General Meeting held in the village hall on the Wednesday evening, we had a very interesting talk by our President, Dr James Davidson, on a plant-hunting holiday spent in Yugoslavia, illustrated by many excellent colour slides.

In the following list of ferns seen during the Excursion, figures 1–33 (bold = new record for the *Atlas of the British Flora*) refer to localities:

Asplenium adiantum-nigrum — **19**
A. ruta-muraria—*1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 22, 23, 24, 29, 31, 32, 33*
A. trichomanes — *1, 2, 3, 5, 6, 8, 9, 11, 12, 13, 14, 15, 16, 17, 19, 22, 23, 24, 25, 29, 31, 32, 33*
A. viride — *7, 9, 12, 13, 14, 17, 21, 23, 24, 25, 29, 32*
A. viride 'Bifidum' — *14*
Athyrium filix-femina — *1, 2, 7, 9, 12, 14, 16, 17, 18, 23, 27, 28*, **29, 33**
Blechnum spicant — *12, 18, 33*
B. spicant 'Anomalum' — *12*
Cystopteris fragilis — **3**, *6, 9, 10, 11 12, 13, 14, 15, 16, 19, 20, 21, 22, 23, 24, 25, 29, 31, 32*
Dryopteris borreri — *7, 9, 12, 18, 23, 29*
D. dilatata — *1, 3, 7, 9, 11, 12, 16, 17, 18*, **20, 27, 30, 31**, *33*
D. filix-mas — *1, 2, 3, 4, 6, 7, 9, 10, 12, 14, 15, 16, 18, 20, 22, 23, 24, 28, 29, 30, 31, 32, 33*
D. filix-mas 'Grandiceps' — *15*
D. villarii — *9, 12, 13, 14, 15*
Equisetum arvense — *8, 17, 23*
E. sylvaticum — *23*
Gymnocarpium dryopteris — *17*
G. robertianum — *9, 12, 13, 14, 24, 29*
Lycopodium selago — *17*

Ophioglossum vulgatum — *15*
Phyllitis scolopendrium — *1, 4, 9, 12, 13, 14, 15, 17, 22, 29*
Polypodium interjectum — **3**, *11, 20, 23, 31, 33*
P. interjectum × P. vulgare — **3**
P. vulgare *sensu stricto* — **3**, *9, 10, 12, 16, 18, 23, 26, 28, 29, 33*
P. vulgare *aggregate* — *6, 14, 15, 17, 22, 32*
Polystichum aculeatum — *7, 9, 12, 15, 23*, **28**, *31, 32*
P. lonchitis — *12*
Pteridium aquilinum — *1, 7, 9, 13, 14, 16, 17, 18, 23, 24, 29, 30, 32, 33*
Selaginella selaginoides — *15, 17*
Thelypteris limbosperma—**7**, *17, 18*, **23, 27, 30**
T. phegopteris — *17*

	V.C. 64 Mid West Yorkshire (*O.S. 1 in. map ser. 7 sheets 90, 91, 95, 96*	Date visited September	National Grid Ref.
1	Austwick, road to north of	8	34/ 7669, 7769, 7770
2	Bolton Abbey	6	44/ 0753
3	Eshton Bridge, roadside at	6	34/ 9455, 9456
4	Fountains Abbey	6	44/ 2768
5	Gargrave, canal banks and walls	6	34/ 9354
6	Gordale Bridge	6	9163
7	Grass Wood	3	9865
8	Horton-in-Ribblesdale station	7	8072
9	Ingleborough, limestone pavement at Chapel-le-Dale	4	7477
10	Kirby Malham	6	8960, 8961
11	Malham Tarn Wood	6	8867
12	Moughton Fell	7	7971
13	Moughton Fell, approach at Beecroft Hall	7	7972
14	Pot Scar	4	7968
15	Ribblehead station, railway cutting near	7	7778
16	Wharfe	8	7869
17	Wharfe Wood	8	7868
18	White Stone Wood, lane near	8	7770
	V.C. 65 North West Yorkshire (*O.S. 1 in. map ser. 7 sheet 90*)		
19	Brough Pasture, Bainbridge	5	9389
20	High Blean	5	9287
21	Jeffery Pot	5	8783
22	Kettlewell	2–9	9672, 9772
23	Langstrothdale, gill between Horse Head Moor and Kirk Gill Moor	3	9178
24	Middlesmoor Pasture Scars	4	9671, 9672
25	Nethergill, hill slopes north of	5	8682
26	Raydale House	5	9084
27	Raydale Wood	5	8984
28	Raydale Wood, valley to west of	5	8984
29	Scar Gill	3	9770, 9771 9870, 9871
30	Stalling Busk	5	9185
31	Thornton Lodge	5	9689
32	West Scale Park	2	9774
	V.C. 69 Westmorland and North Lancashire (*O.S. 1 in. map ser. 7 sheet 89*)		
33	Kingsdale Beck, Ingleton	4	6973, 6974

FERN CLASSES AT SOUTHPORT FLOWER SHOW

23–25 AUGUST 1967

Mr W. G. Mackenzie and I met once more at Southport to judge the fern exhibits, and it seemed to us that the standard of the exhibits was, in general, higher than ever

Class 10 was, as usual, superlatively staged by Noel Brookfield whose specimens of *Polypodium vulgare* varieties were in wonderful condition, amongst many fine specimens of *Phyllitis*, *Polystichum* and *Athyrium*. The recently introduced Class 11 attracted three entries, all excellent. We were impressed by the very good plants used in Classes 12 and 14, and it was quite difficult to fault the entries. When competition becomes very close, it depends on every detail of the plants being in perfect condition, and each plant in a group has to pull its full weight to obtain a "first". In one or two instances very fine specimens had to be given lower awards on account of slight weather damage. Although it is desirable that hardy ferns should be grown as such and not given greenhouse protection, due attention to siting in the garden and provision of shading can make all the difference to the appearance of specimens on the show bench.

For Class 22 there was but one entry which included *Thelypteris palustris* and strictly this entry should have been rejected as not according to the schedule which says "(excluding genera recently included in Dryopteris and Lastrea)". The Southport Show authorities, at my suggestion, have agreed to drop this exclusion clause in future.

One of the finest specimens in the show was in Class 25. The plant of *Adiantum cuneatum*, while presenting no particular difficulty, really was outstanding and must have taken many years to attain its colossal size, every frond being perfect. It must have been no mean feat transporting such a huge specimen, without harm, to the show bench.

R. KAYE

PRIZE WINNERS AND THEIR ENTRIES

CLASS 10 A group of hardy British ferns, with accent on diversity of species and variation, arranged in a natural manner in a space 13 feet by 8 feet and not higher than 6 feet above the ground:
1st Messrs J. Brookfield & Son who continue to hold the Silver Perpetual Challenge Trophy presented by the British Pteridological Society

CLASS 11 A display of not more than 20 diverse hardy British ferns, in a space not exceeding 8 feet by 5 feet:
1st Messrs Brookfield
2nd B. Hayhurst
3rd W. M. Howarth

CLASS 12 Six dissimilar hardy British ferns with accent on variation:
1st Messrs Brookfield: *Athyrium filix-femina* 'Victoriae', *A.f.* 'Fieldiae', *Phyllitis scolopendrium* 'Ramo-cristata', *Polypodium vulgare* 'Oxford', *Polystichum aculeatum* 'Gracillimum', *P. setiferum* 'Divisilobum Iveryanum'
2nd B. Hayhurst: *Athyrium filix-femina* 'Frizelliae', *A.f.* 'Frizelliae Cristatum', *A.f.* 'Victoriae', *Dryopteris dilatata* 'Succisa', *Polystichum setiferum* 'Divisilobum Iveryanum', *P.s.* 'Imbricato-cristatum'

CLASS 13 Six foreign ferns hardy in Great Britain:
1st B. Hayhurst: *Adiantum* sp. (Himalayan), *A. pedatum* var. *aleuticum* 'Imbricatum', *Blechnum tabulare*, *Dryopteris wallichiana*, *Phymatodes diversifolia*, *Polystichum* sp. (New Zealand)
2nd Messrs Brookfield: *Adiantum tenellum*, *Blechnum* sp. (dwarf), *Cyrtomium falcatum*, *Matteuccia struthiopteris*, *Onoclea sensibilis*, *Pellaea hastata*

CLASS 14 Six dissimilar greenhouse ferns:
1st Messrs Brookfield: *Adiantum cuneatum* 'Kensington Gem', *Davallia canariensis, Microlepia hirta, Platycerium alcicorne, Polypodium aurem* var. *areolatum, Pteris cretica* 'Albo-lineata'
2nd B. Hayhurst: *Adiantum cuneatum, A. cuneatum* 'Kensington Gem', *Davallia bullata, Nephrolepis exaltata, N.* 'Rosea', *Platycerium alcicorne*
3rd W. M. Howarth: *Adiantum cuneatum, Asplenium bulbiferum, Cyrtomium falcatum, Nephrolepis acuminata* 'Furcans Plumosa', *Pteris cretica* 'Albo-lineata', *P.c.* 'Major'

CLASS 15 Three distinct normal species of hardy British ferns:
1st Messrs Brookfield: *Adiantum capillus-veneris, Blechnum spicant, Phyllitis scolopendrium*
2nd N. Robinson: *Dryopteris aemula, Polypodium vulgare, Polystichum aculeatum*

CLASS 16 Three foreign ferns hardy in Great Britain:
1st Messrs Brookfield: *Adiantum venustum, Matteuccia struthiopteris, Pellaea rotundifolia*
2nd N. Robinson: *Adiantum pedatum* var. *aleuticum, Blechnum penna-marina, Polystichum munitum*

CLASS 17 Three distinct varieties of *Phyllitis scolopendrium:*
1st B. Hayhurst: 'Crispa', 'Drummondii', 'Ramo-cristata'
2nd Messrs Brookfield: 'Crispa', 'Drummondii', 'Ramo-cristata'

CLASS 18 Three distinct varieties of *Polypodium vulgare:*
1st Messrs Brookfield: 'Grandiceps', 'Hadwinii', 'Oxford'
2nd B. Hayhurst: 'Grandiceps Cowan', 'Hadwinii', 'Pulcherrimum'
3rd N. Robinson: 'Hadwinii', 'Longicaudatum', 'Pulcherrimum'

CLASS 19 Three distinct varieties of *Polystichum:*
1st B. Hayhurst: *P. aculeatum* 'Pulcherrimum Bevis', *P. setiferum* 'Divisilobum densum', *P.s.* 'Divisilobum Iveryanum'
2nd Messrs Brookfield: *P. aculeatum* 'Gracillimum', *P.a.* 'Pulcherrimum Bevis', *P. setiferum* 'Wakeleyanum'
3rd N. Robinson: *P. aculeatum* 'Pulcherrimum Bevis', *P. setiferum* 'Acutilobum Proliferum', *P.s.* 'Divisilobum Iveryanum'

CLASS 20 Three distinct varieties of *Athyrium filix-femina:*
1st B. Hayhurst: 'Frizelliae Capitatum', 'Plumosum Druery', 'Victoriae'
2nd Messrs Brookfield: 'Congestum Paul', 'Cristatum', 'Victoriae'

CLASS 21 Three distinct varieties of *Dryopteris:*
1st Messrs Brookfield: *D. filix-mas* 'Cristata' (two forms), *D.f.* 'Depauperata Cristata'
2nd N. Robinson: *D. borreri* 'Angustata Cristata', *D. filix-mas* 'Cristata', *D.f.* 'Depauperata Cristata'
3rd B. Hayhurst: *D. borreri* 'Angustata Cristata', *D. dilatata* 'Succisa', *D. filix-mas* 'Depauperata Cristata'

CLASS 22 Three *Gymnocarpium* and/or *Thelypteris:*
1st Messrs Brookfield: *Gymnocarpium dryopteris, G. robertianum, Thelypteris palustris*

CLASS 23 Three distinct varieties and/or species of *Asplenium:*
1st (no award)
2nd Messrs Brookfield: *A. adiantum-nigrum, A. ruta-muraria, A. trichomanes*

CLASS 24 One British fern of any kind or variety:
1st W. M. Howarth: *Polystichum setiferum* 'Divisilobum'
2nd M. Plowman: *Polystichum setiferum* 'Divisilobum Plumosum'
equal 2nd Messrs Brookfield: *Polystichum setiferum* 'Acutilobum'

CLASS 25 One greenhouse fern:
1st M. Plowman: *Adiantum cuneatum* 'Fritz Luthii'
2nd Messrs Brookfield: *Adiantum cuneatum* 'Kensington Gem'
3rd B. Hayhurst: *Adiantum cuneatum* 'Kensington Gem'

N. ROBINSON

REVIEWS

HARDY FERNS by Reginald Kaye, 203 pages, 28 photographs—4 in colour, 26 composite line drawings. Faber and Faber Ltd, London 20 May 1968. Price 63s.

This eagerly awaited book fulfils a long-felt need, and is all we have wanted it to be. The author has been soaked in his subject from his earliest years, and I doubt if there is anything that anyone can tell him about the growing of hardy ferns. There is only one real criticism I can make—it is inadequate by the limits of space and cost to put on record his vast reservoir of fern knowledge. But he has preserved a good balance throughout, covering all aspects of his subject in a lucid way which will make the book an invaluable acquisition to all who aspire to grow ferns and at the same time wish to know something about the plants they are growing.

The book is written by a gardener and fern-grower, and is primarily for those with similar interests. It tells us about our native ferns as well as hardy ferns from other countries, with expert cultural instructions. As an alpinist too, Mr Kaye has much useful information to impart on growing the smaller ferns and their value in rock gardens and stone walls. There are excellent chapters on the cultivation of hardy ferns under glass, in bottles and as house plants, and those who want to experiment with spore-sowing, the propagation of ferns by bulbils and other means, and even hybridisation, will find all the information they require in this book.

The lists of the fern varieties still available today make the book extremely useful to the collector, although even Reginald Kaye cannot know what overlooked pearls from our lost treasure-house of ferns still lurk in unsuspected garden corners throughout the country. For the grower, the many fine variations of British ferns are of the greatest interest, and these are fully dealt with and well described. A most informative inclusion is the chapters on the identification and description of species and varieties, and the table for their classification. This table, a modified combination of those previously published by Lowe, Dyce and the author, will prove extremely valuable in helping new growers to sort out the many kinds of variation which can be so confusing to the beginner.

Mr Kaye is a master of his subject and there is very little of importance that one can find to fault in the book from the angle of the fern-grower. Our botanical friends are more critical of the technical side and will no doubt return the sly digs which he has aimed at them with that typical northern humour which endears him to all of us—including our botanists. However as the book is not written for botanists, any faults readily perceptible to their trained minds will in no way detract from its value, and there is only one other criticism I have to make—there are not enough colour photographs. Apart from this omission, obviously done to keep the cost down, the publishers have done an excellent job, and the presentation is of high standard. At 63 shillings the book may seem a lot of money, but it is well worth every penny of its price, and should be on the bookshelves of everyone interested in the collecting and growing of hardy ferns.

J. W. DYCE

The reason for adding to Mr Dyce's praise of this book is because my name is mentioned with Mr Jermy's in the Introduction as 'my good friends who will forgive me I hope for sundry sly digs at the botanists'.

In my opinion, and I speak for Mr Jermy in this, these 'sly digs' are valid, but one could often take Mr Kaye to task for half truths and inaccuracies. His interpretation of the international rules of nomenclature gives a queer format for his plant names. There are several inaccurate and misleading statements, and curious inconsistencies throughout.

For us however, such blemishes fade into insignificance when set against the general excellence of the book.

Here we have a superb example of bridging a gulf between two professional prides, and Mr Kaye is qualified to represent both sides which he illustrates by the botanist who describes some of our fern varieties as genetically monstrous types, and the gardener who would not know the difference between a chromosome and a cobblestone. He adds that a little tempering of both extremes might not be a bad thing.

When this book was in preparation I suggested he might like Mr Jermy and myself to read his manuscript. But this offer was declined with gentlemanly charm. He wanted the result to be entirely his own monograph, text and illustrations. As I read, the whole book exudes the jovial personality of the author, and each word for me is nostalgia through a cloud of pipe smoke in North Country brogue, sometimes in his Silverdale nursery, sometimes as we delve together in ferny places.

J. A. CRABBE

INDEX TO BOTANICAL MONOGRAPHS: A GUIDE TO MONOGRAPHS AND TAXONOMIC PAPERS RELATING TO PHANEROGAMS AND VASCULAR CRYPTOGAMS FOUND GROWING WILD IN THE BRITISH ISLES. Compiled by D. H. Kent. BSBI and Academic Press, London and New York 1967. Price 42s.; *$7.75.*

As Douglas Kent says in the Introduction no compilation such as this has been attempted since B. D. Jackson's *Guide to the Literature of Botany* (1881). The work under review contains some 1,900 references to taxonomic books and papers published since 1800 (although a few published prior to that date are included); over 300 periodicals have been searched and as a spare time project (and one of several) this book is a very worthy effort. To the all-round botanist the book is indispensable and the horticulturalist will find useful references to alien and often cultivated plants. The list of abbreviations of periodicals (pp. 1–24) is in itself a very valuable aspect.

The references are indexed under family and genus headings arranged according to Dandy's *List of British Vascular Plants.* Mr Kent, however, follows *Flora Europaea* in his treatment of *Lycopodium* and recognises four genera but apart from one reference to the *Complanata* section of *Lycopodium,* no other author does; and nine references are repeated four times instead of being placed either under *Lycopodium* s.l. or the family. Such inefficient use of space and type-setting is costly. It would have been useful to know if a paper contained a key or good illustrations.

It must have been very difficult to decide what to include and what to omit in a book of this nature. There are some omissions which would have been more useful to the fern enthusiast. I would have preferred to see papers on close European taxa included in case the subspecies or such turned up in Britain. Lovis' and Reichstein's paper on *Asplenium ruta-muraria* was left out one assumes because the taxon described therein was not British. I would also prefer a reference to a paper giving differences between British species rather than a reference to a general tropical family monograph e.g. Copeland's *Genera Hymenophyllacearum* (1938). The papers recently published in the *Gazette* on variation in *Athyrium* and *Polystichum* are omitted on grounds that they are not wild, as are some of the standard works on British Ferns which stress varieties (Lowe, Moore, Druery, etc.). The absence of T. Moore's *Handbook of British Ferns* is unfortunate for it was in Ed. 3 of this book that *Lastrea dilatata* var. *alpina* (*Dryopteris assimilis* S. Walker) is first described and several other of Moore's forms may turn out to be of evolutionary, and therefore taxonomic, importance.

In my experience one uses a book like this a great deal when it is permanently at one's elbow; it is 42/- well spent.

A. C. JERMY

EXCURSION FLORA OF THE BRITISH ISLES by A. R. Clapham, T. G. Tutin and E. F. Warburg, 2nd edition; xxxv, 586 pages. Cambridge University Press, 18 April 1968. Price 30s.

This pocket size edition of the C.T.W. *Flora of the British Isles* has been thoroughly revised with regard to current taxonomic thought and recent nomenclatural changes and follows, as far as the pteridophytes are concerned, *Flora Europea* and the BPS Census List (Brit. Fern Gaz. Suppl. 1959). Keys and full descriptions are given to the families and the 62 species of fern, lycopod and horsetail. Substantial differences from the first edition and from the major *Flora* are seen in the recognition of *Gymnocarpium* Newm. as a genus, separated from *Thelypteris* and put, rightfully, in Aspidiaceae, for it has no close affinities with other Thelypterids. The *Dryopteris filix-mas* agg. is still unsatisfactory and indicates the need for more work on the complex; one hopes in the next few years, through the work of Corley and others, this need will be filled. The key leads one to think there is only one (alpine) form of *C. abbreviata*, for instance; there is a diploid, large-fronded, lowland form, recognised, at the moment, only by the specialist. The authors have not had the courage to go one stage further than *Flora Europea* and sink *Phyllitis* and *Ceterach* into *Asplenium*; there are, however, no grounds for keeping them as separate genera—they hybridize with each other and with *Asplenium* and play an important part in the evolution of that genus.

A. C. JERMY

GUIDANCE FOR AUTHORS

Anything from a short note to a more lengthy discourse is welcomed in English on any aspect of pteridology. Contributions should be sent to A. C. Jermy, British Museum (Natural History), London, S.W.7. Twenty-five reprints are supplied free. More may be purchased and must be ordered when proofs are returned. The cost will be quoted when proofs are sent.

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A **summary** should be compiled by the author when appropriate.

Sub-headings, in conjunction with a concise title, improve layout; they and titles should not be underlined.

Footnotes may be used if really necessary, or as a means of quoting references in short notes. Their points of reference should be numbered consecutively in the text and should be given immediately below the line in which the reference occurs.

Latin names should be underlined and the authority given (usually) at the first mention only.

Keys should be dichotomous, indented and numbered, e.g.:

1 Leaves simple .. .. *hemionitis*
1 Leaves compound
    2 Petiole glandular-hairy
        3 Pinnae suborbicular, shortly stalked .. .. .. *petrarchae*
        3 Pinnae oblong, adnate to rhachis .. .. .. *jahandiezii*
    2 Petiole glabrous
        4 Lamina 3-4 pinnate, lanceolate .. .. *fissum*

References should be given either in the narrative or in parenthesis e.g.: "SHIVAS in 1962 points out . . . " or "It has been pointed out (SHIVAS 1962, p. 69) that . . .". The list of references at the end of the paper should be in alphabetical order under author in the following format:

MANTON, I. 1950. Problems of cytology and evolution in the Pteridophyta. Cambridge.

SHIVAS, M. G. 1962. The Polypodium vulgare complex. Brit. Fern Gaz. 9: 65-70.

Cyrillic, etc. alphabets should be transliterated into the English form. Illustrations should be submitted either as glossy black and white photographs (same size as final plate) or black and white line-drawings (up to twice their final size). Graph-paper with blue rulings should be used when a fine grid is required for construction only.

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THE BRITISH FERN GAZETTE

VOL. 10 PART 1 1968

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Printed by the Devonshire Press, Torquay, England

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THE BRITISH FERN GAZETTE

VOLUME TEN PART TWO

1969

THE JOURNAL OF THE
BRITISH PTERIDOLOGICAL SOCIETY

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This number is dedicated
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Honorary Member and Vice-President
of the British Pteridological Society
and
Professor of Botany at Leeds University
1946 - 1969

Further contributions submitted for this occasion
will appear in the next number

SMITHSONIAN INSTITUTION SEP 23 1969

The BRITISH FERN GAZETTE Volume 9 Part 8
was published on 23 August 1967

The next Part, Volume 10 Part 1 was published on
27 September 1968

THE RESYNTHESIS AND CYTOGENETIC INVESTIGATION OF X *ASPLENOPHYLLITIS MICRODON* AND X *A. JACKSONII*

J. D. LOVIS* and G. VIDA**

INTRODUCTION

Interest in the Channel Islands putative spleenwort/hart's tongue hybrids was reawakened by the rediscovery by Girard (JEE 1966, GIRARD 1968) of an example of × *Asplenophyllitis microdon* (T. Moore) Alston in Guernsey, after an interval of perhaps more than eighty years.

As was reported in the last issue of the *Gazette* (GIRARD & LOVIS 1968) this remarkable find was subsequently investigated cytologically, resulting in it being established beyond any reasonable doubt that this fern is a hybrid between *Phyllitis scolopendrium* (L.) Newman[1] and a species of *Asplenium*. Morphological evidence indicated that the *Asplenium* parent of this hybrid was probably *A. billotii* F. W. Schultz, but although the most likely interpretation of the cytological evidence would confirm this conclusion, complete certainty was not possible. It was evident that final solution of this question and of other problems concerning this hybrid and the related × *A. jacksonii* Alston might have to await artificial reconstruction of these two hybrids.

A return visit to Leeds in the summer of 1967 by Gabor Vida, who had already achieved success in the production of two artificial × *Asplenophyllitis* hybrids (VIDA 1966), provided an obvious opportunity to attempt these syntheses. A series of hybridisation attempts were therefore conducted by us, both in collaboration and in parallel, in the hope that combined forces might bring immediate success. This hope was fulfilled, and it is the primary purpose of this paper to describe the synthesis of *Asplenium billotii* × *Phyllitis scolopendrium* and *A. adiantum-nigrum* × *P. scolopendrium*, and to present a report on the cytogenetic analysis of these hybrids.

PREVIOUS EXAMPLES OF ARTIFICIAL HYBRIDS BETWEEN SPECIES OF *ASPLENIUM* AND *PHYLLITIS*

What appears to be certainly the first example of an *Asplenium*/*Phyllitis* hybrid being obtained in cultivation was the plant called × *Asplenophyllitis claphamii* by ALSTON (1940). This plant, first reported by LOWE (1867, p. 155) as *Asplenium lanceolatum* var. *Claphamii* from a specimen sent to Thomas Moore, had appeared quite accidentally and seemingly spontaneously in the fernery of Mr Clapham of Scarborough. Alston commented that it was intermediate between × *Asplenophyllitis microdon* and *Phyllitis scolopendrium*, and noted that it was possible that the plant was a 'secondary hybrid' (i.e., a hybrid between × *A. microdon* and *P. scolopendrium*, or selfed progeny from × *A. microdon*—cf. ALSTON 1940, p. 135

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[1] A discussion of the virtue of the use of the name *Asplenium scolopendrium* L. instead of *Phyllitis scolopendrium* (L.) Newman, and an explanation of the use of the latter name here, against our personal conviction, are given later in this paper.

and 141). This now seems unlikely, in view of the meiotic behaviour of × *A. microdon* (GIRARD & LOVIS 1968). We note that Dr Janet Souter synthesised an × *Asplenophyllitis* hybrid with a strong resemblance to × *A. claphamii.*

The second known example of the production of an × *Asplenophyllitis* hybrid under conditions of cultivation was obtained, also apparently entirely accidentally, by Mr Amedée Hans of Long Island, N.Y., who from amongst a sowing of *Phyllitis scolopendrium* acquired not only a few stray sporelings of *Asplenium trichomanes* but also a single example of × *A. confluens* (T. Moore) Alston (HANS 1916, STANSFIELD 1928). As far as is known to us, this plant was never investigated cytologically, and is no longer in cultivation.

Deliberate artificial synthesis of an × *Asplenophyllitis* hybrid was first achieved by Janet Souter (née EMMOTT 1963, 1964) who successfully hybridised *Phyllitis hybrida* (Milde) C.Chr. with *Asplenium macedonicum* Kümmerle. This hybrid unfortunately died soon after reaching maturity. She also produced in the same hybridisation programme another hybrid more directly relevant to the present investigation, namely *Asplenium obovatum* Viv. × *Phyllitis scolopendrium* var. *americana* Fernald. The ploidy of this hybrid, which is tetraploid, requires explanation, since *P. scolopendrium* var. *americana* is known to be tetraploid, but *A. obovatum* is diploid. The expected ploidy of their hybrid is therefore triploid. The explanation of this anomaly proposed by Dr Souter is that the contribution of *A. obovatum* (the female parent) to the hybrid was in duplicate, owing to the hybridised prothallus having arisen from a spore with unreduced chromosome number. However, it can now be seen that the meiotic pairing behaviour of this hybrid (63–69 bivalents & 18–6 univalents, EMMOTT 1964) does not after all exclude the possibility that it was produced on a stray prothallus of *A. billotii* (a very close relative of *A. obovatum,* but itself tetraploid, not diploid). The question of the *exact* parentage of this hybrid therefore remains uncertain. There is a considerable resemblance between Dr Souter's hybrid and the mysterious × *Asplenophyllitis claphamii* mentioned above. This fact provides some guide to the likely true nature of the latter plant, which clearly could have originated as a first generation hybrid between *Phyllitis scolopendrium* and a member of the *billotii/obovatum* group of *Asplenium.* Dr Souter's plant is still in cultivation in Leeds, and its spores have give rise to seven progeny plants, four of which still survive.

Artificial × *Asplenophyllitis* hybrids have also been obtained by Gabor Vida in Budapest, subsequent to his discovery near Pécs in Hungary of *Asplenium* × *kummerlei* Vida (× *Asplenophyllitis kummerlei* (Vida) Soó), a natural hybrid between *Asplenium lepidum* C. Presl and *Phyllitis scolopendrium.* Prior to the detection of the presence of *A. lepidum* in the locality, this wild hybrid was at first (VIDA 1961) interpreted as *A. rutamuraria* L. × *P. scolopendrium*, but it was possible to settle this question beyond all doubt by synthesis in 1963 of hybrids between *A. lepidum* and *A. rutamuraria* with *P. scolopendrium* (VIDA 1965). Both of these hybrids are still in cultivation and have been increased by vegetative division.

The only recorded previous attempts to synthesise × *Asplenophyllitis microdon* or × *A. jacksonii* were made by Stansfield more than forty years ago, but these experiments were not successful (STANSFIELD 1923, 1924).

HYBRIDISATION TECHNIQUE AND RESULTS

The technique used in our experiments was exactly as described at length in the last issue of the *Gazette* (LOVIS 1968) and therefore need not be considered further here.

In our experiments, *Asplenium billotii* × *Phyllitis scolopendrium* proved to be very much easier to produce than *A. adiantum-nigrum* × *P. scolopendrium.* No less than 25 examples of the former hybrid were obtained. Two hybridisation attempts were remarkably successful, in each case five hybrid sporophytes being obtained from eight 'female' prothalli inseminated together. The performance of one prothallus in another attempt, deserves to be recorded, for it produced three sporophytes, two hybrid and one 'selfed' (FIGS 1–3).

In contrast, only two examples of *Asplenium adiantum-nigrum* × *Phyllitis scolopendrium* have been successfully raised to maturity. A third sporophyte must surely also be hybrid, but so far has only produced sterile fronds of mostly aberrant and irregular appearance. A list of the cultures used in the hybridisation attempts is given as an Appendix and an analysis of the results of these experiments are given below.

Hybridisations

Hybridisations were attempted between 28.5.1967 and 10.11.1967. The only successful combinations were:

Asplenium billotii Ronco ♀ × *Phyllitis scolopendrium* Szuado ♂
Asplenium billotii Ronco ♀ × *Phyllitis scolopendrium* Lusta ♂
A. adiantum-nigrum Kynance ♀ × *P. scolopendrium* Szuado ♂
A. adiantum-nigrum Kynance ♀ × *P. scolopendrium* Lusta ♂

Hybridisation attempts:
A. billotii ♀ × *P. scolopendrium* ♂
24 attempts totalling 218 prothalli: hybrids obtained 25; percentage success: 11%
P. scolopendrium ♀ × *A. billotii* ♂
2 attempts, totalling 28 prothalli: hybrids obtained 0
A. adiantum-nigrum ♀ × *P. scolopendrium* ♂
42 attempts, totalling 395 prothalli: hybrids obtained 3; percentage success: 0.75%
P. scolopendrium ♀ × *A. adiantum-nigrum* ♂
4 attempts, totalling 60 prothalli: hybrids obtained 0.

CYTOLOGY

Developing sporangia were fixed, stained, and preparations made permanent according to MANTON (1950, pp. 295–6).

Parental strains: The chromosome number of each of the strains successfully used in hybridisation experiments has been controlled. Thus *Asplenium billotii* from Ronco (MANTON & REICHSTEIN 1962, FIG. 5) and *A. adiantum-nigrum* from Kynance (PLATE 2A & FIG. 28) are both tetraploid, while *Phyllitis scolopendrium* from both the Szuado and Lusta valleys is diploid.

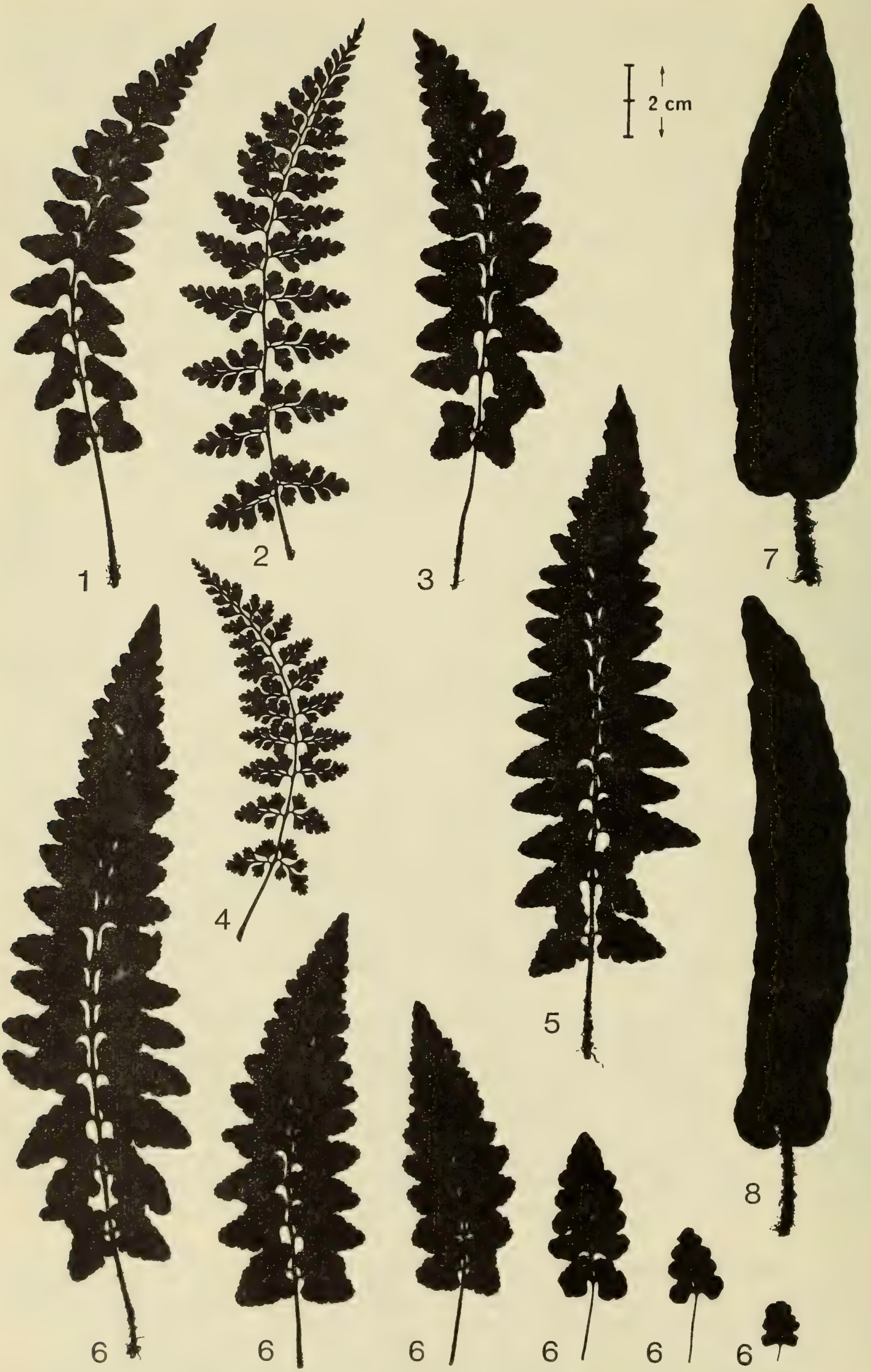
A. billotii × *P. scolopendrium:* (PLATE 1 & FIGS 22–27).

The meiotic cytology of the synthesised hybrids is indistinguishable from that of the wild *X Asplenophyllitis microdon* plant from Castel (GIRARD & LOVIS 1968, PLATE 1: B & D, FIGS 2 & 3; GIRARD 1968). To date, six plants have been examined. These plants are triploid, with an irregular meiosis. Cells successfully analysed showed a range of chromosome pairing from 31–36 small bivalents, with 46–36 mostly comparatively large univalents. The pairing found in the thirty cells investigated was as follows: 31 bivalents (1 cell), 33 (3), 34 (8), 35 (12), 36 (6).

A. adiantum-nigrum × *P. scolopendrium:* (PLATE 2: B–F & FIGS 29–33).

Both examples are triploid, as expected, and show virtually complete failure of chromosome pairing. Half of the twenty cells analysed showed no clear bivalents, but up to a maximum of six bivalents have been seen in other cells.

The meiotic process is far more irregular in *Asplenium adiantum-nigrum* ×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Phyllitis scolopendrium than in *A. billotii* × *P. scolopendrium.* The process of division usually stops in the first metaphase, resulting in one or two large nuclei and a few smaller ones within the same cell. The sporangium therefore contains 16 shrunken bodies rather than the 64 abortive spores usually seen in the case of *A. billotii* × *P. scolopendrium.* In this latter hybrid meiosis appears always to proceed to the tetrad stage.

DISCUSSION AND CONCLUSIONS

Identity and typification of × *Asplenophyllitis microdon* and × *A. jacksonii*

In the case of × **Asplenophyllitis microdon** (Moore) Alston, the choice of a type is straightforward. This taxon is based on *Asplenium marinum* var. *microdon* MOORE (1855), as is also *A. lanceolatum* var. *microdon* (Moore) MOORE (1857). MOORE indicates (1860, p. 73) that he was indebted to Mr C. Jackson for specimens of this plant. There are two fronds in the Moore Herbarium (K) labelled 'Guernsey 1855/C. Jackson/"apiculatum"/M.', which were accepted by Alston (MS note in BM negative collection) as the type material. The finer of these two fronds, illustrated here in silhouette (FIG. 14) is now selected as a lectotype for *A. marinum* var. *microdon* Moore.

X **Asplenophyllitis jacksonii** Alston is based on *Asplenium adiantum-nigrum* var. *microdon* MOORE (1860). The type of this taxon, and therefore of × *A. jacksonii,* must be a specimen already present in Moore's herbarium by this date.[2] MOORE (1860, p. 89) cited three collections of *A. adiantum-nigrum* var. *microdon:* 'This remarkable plant has been found in Guernsey by Mr C. Jackson, and in Devonshire by the Rev. J. M. Chanter, and more recently in the neighbourhood of Barnstaple, by Mr Jackson.'

The plant found by Rev. Chanter is represented in the Moore Herbarium by one diminutive frond dated 1856, evidently formed in the wild, and two large fronds labelled 'Hort. Chanter 1859'. Another sheet in the Moore Herbarium contains an incomplete frond labelled '*Asplenium marinum* var./Guernsey Mr C. Jackson/June 1856', flanked by single small immature fronds labelled 'Hort. Jackson 1857' and 'Hort. Jackson 1858'. Below are three mature fronds labelled 'Hort. Jackson 1859/"scolopendrioides" Jackson' which carry a printed 'Type Specimen' label, and one frond from 'Muddiforth 1860/C. Jackson'. It seems probable that with the exception of the Muddiforth (Barnstaple) specimen, all the fronds on this sheet came from the same plant, in which case the ragged 1856 frond represents the plant as originally found, and the small 1857 and 1858 fronds record stages in the gradual recovery of the plant after transfer into cultivation, full vigour and development being attained in 1859. A MS note in the BM negative collection makes it clear that Alston did not attach the type specimen label, and that he regarded the original 1856 frond from Guernsey as the type.

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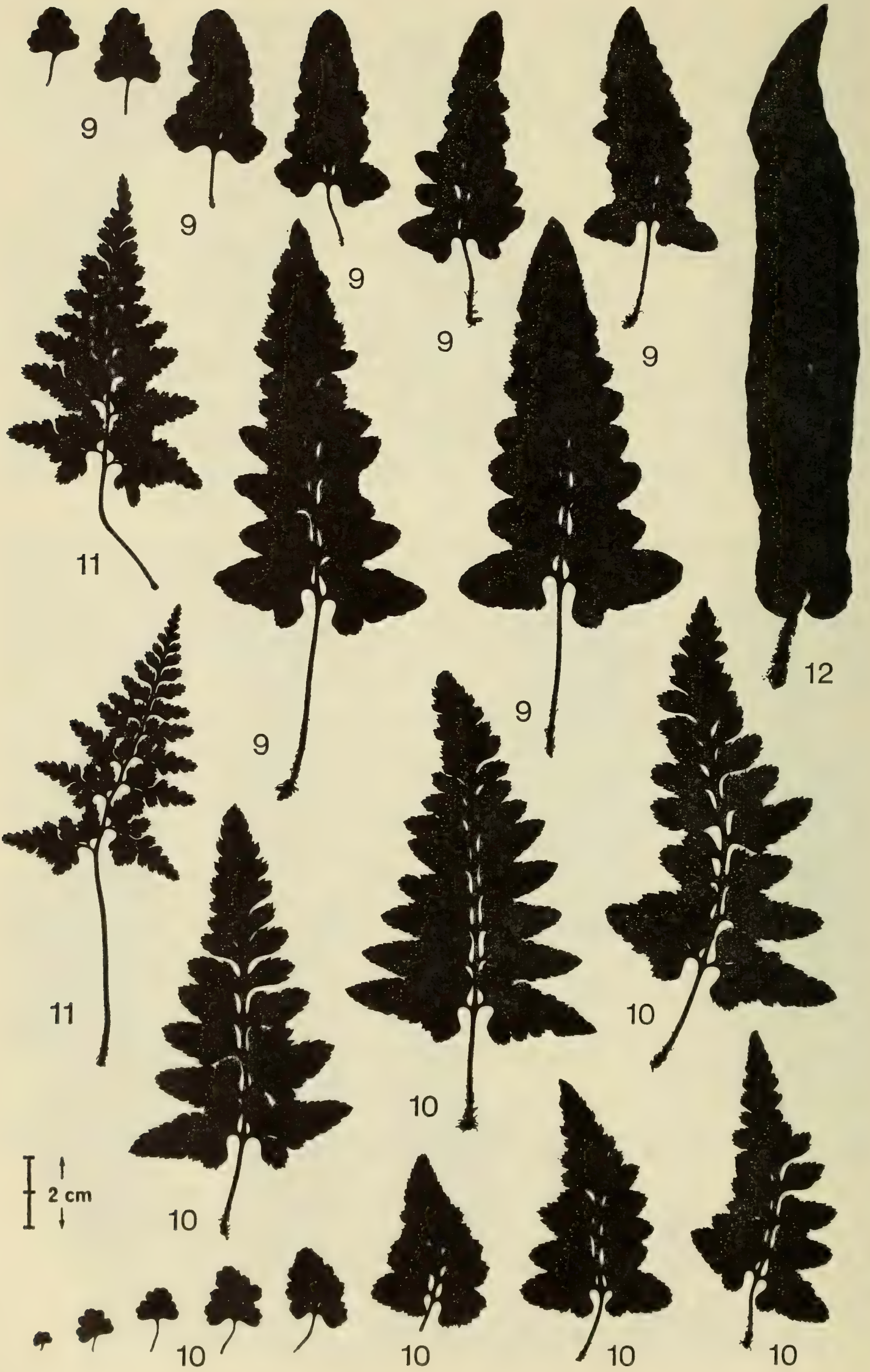
[2] The frond illustrated by ALSTON (1940), although an excellent example of this hybrid, cannot be considered as a possible lectotype, since it is dated 1862.

IGURES 1 – 8: Silhouettes of fronds of synthetic *Asplenium billotii* × *Phyllitis scolopendrium* ybrids and parent species, all from cultivation at Leeds. Half natural size. Figs **1**–**3**: three porophytes produced by one prothallus, JDL 1840A, two hybrid and one self-fertilised. Fig. **1**: . *billotii* × *P. scolopendrium,* JDL 1840:A1, Fig. **2**: *A. billotii* ex Ronco, JDL 1840:A3, Fig. **3**: . *billotii* × *P. scolopendrium,* JDL 1840:A2. Fig. **4**: *A. billotii* ex Wasigenstein, Alsace. Figs & **6**: *A. billotii* × *P. scolopendrium.* Fig. **5**: JDL 1823. Fig. **6**: JDL 1821A, selected series of onds showing stages in development. Figs **7** & **8**: *P. scolopendrium.* Fig. **7**: Szuado valley near Pécs, GV Phs 2c. Fig. **8**: Lusta valley near Miskolc, GV Phs 3c.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In selecting a lectotype, it is necessary to choose that element amongst the original material which best fits the original author's conception of the taxon. Moore's description is clearly based on the mature well-grown fronds obtained in cultivation in 1859. Indeed, he states that his opinion regarding the identity of this plant was changed by acquisition of mature fronds. Thus he writes (1860, p. 89), 'The present when young was referred to the above-named variety [*microdon*] of *lanceolatum*, as a somewhat deltoid form, but now that it has become mature, its fructification sufficiently separates it.' It would therefore be not merely pedantic but wrong to select as a type for this taxon one of the fronds first received by Moore, and for this reason we cannot agree with Alston's opinion.

The claims of the Jackson Guernsey plant and the Chanter Devon specimen to be regarded as the type are finely balanced, and a decision between them is difficult and perhaps academic, since Moore's conception of the plant is evidently based on them both more or less equally. Chronologically, they cannot be separated[3]. Both were first collected in 1856, and in each case it was only fronds obtained in cultivation in 1859 that showed the full mature development of the plant. However, the Jackson (Guernsey) and Chanter plants are not morphologically identical, and in this lies the key to a decision regarding typification. They differ markedly in their soral arrangement, the sori lying very much closer to the midrib in the 1859 Chanter fronds than in the 1859 Jackson specimens. Indeed, in the latter the sori lie scarcely nearer to the midrib than to the margin of the pinnae, each pinna presenting an appearance superficially very reminiscent of a miniaturised *Phyllitis* frond. There can be no doubt, therefore, that in this respect the Chanter fronds fit MOORE's description (1860, p. 89), 'The sori are . . . placed near the costa', very much better than the Jackson collection. For this admittedly slender but tangible reason, the Chanter plant is preferred as a choice of type, and one of these fronds, illustrated here in silhouette (FIG. 17), is selected as a lectotype.

Morphological comparison of synthetic and natural hybrids

Asplenium billotii × *Phyllitis scolopendrium*

The morphology of all the artificial hybrids is very similar (PLATE 3: B, FIGS 1, 3, 5, 6 & 13). In frond shape, and in sorus position and shape, they match very closely the plant of × *Asplenophyllitis microdon* found recently by Girard at Castel (see GIRARD & LOVIS 1968, FIG. 6), the fine series of fronds of this hybrid in Herb. BM from St. Pierre du Bois, Guernsey, collected by Miss Wilkinson in 1855, and most importantly, the lectotype (see above) in the Moore Herbarium at Kew, collected by C. Jackson, also in Guernsey in 1855. The resemblance between this frond and one of our synthetic hybrids is exceedingly close (FIGS 13 & 14).

Asplenium adiantum-nigrum × *Phyllitis scolopendrium*

The two mature examples obtained of this hybrid, although derived from the same combination of parent cultures, are nevertheless different, inasmuch as one (JDL 1846, FIGS 9 & 15) displays a perceptibly less completely divided frond, being

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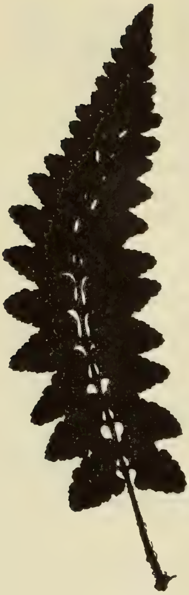
[3] ALSTON (1940) writes of × *Asplenophyllitis jacksonii*, 'Originally found in Devon', but his authority for this statement is not known to us.

FIGURES 9 – 12: Silhouettes of fronds of synthetic *Asplenium adiantum-nigrum* × *Phyllitis scolopendrium* hybrids and parent strains, all from cultivation at Leeds. Half natural size. Figs **9 & 10:** *A. adiantum-nigrum* × *P. scolopendrium*, two selected series of fronds showing stages in development. Fig. **9:** JDL 1846. Fig. **10:** GV 100:1A. Fig. **11:** *A. adiantum-nigrum*, Kynance Cove, two examples of variation in 'selfed' progeny. Fig. **12:** *P. scolopendrium*, Szuado valley near Pécs, GV Phs 2c.



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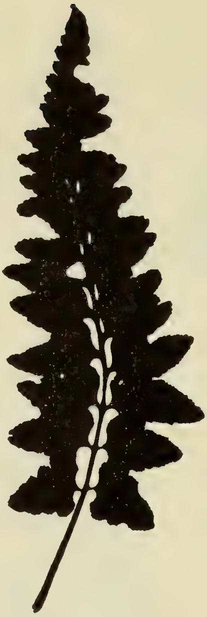

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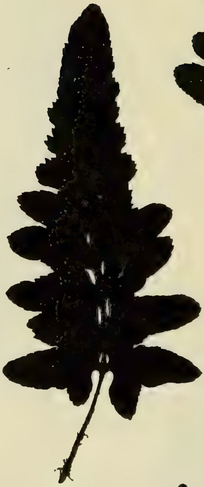

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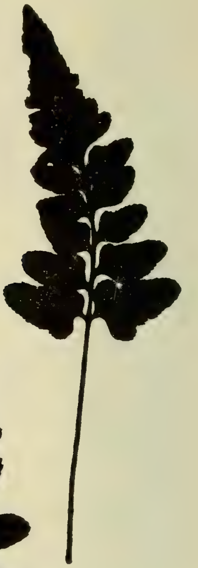

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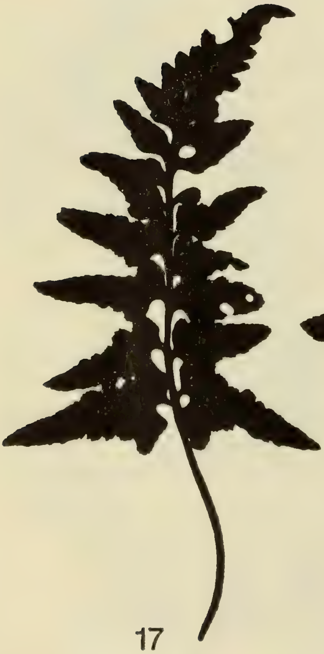

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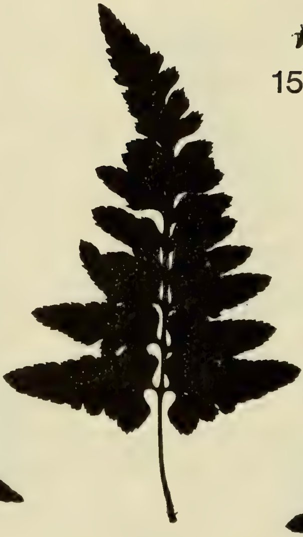

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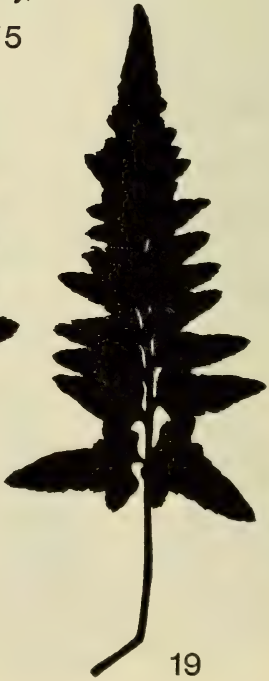

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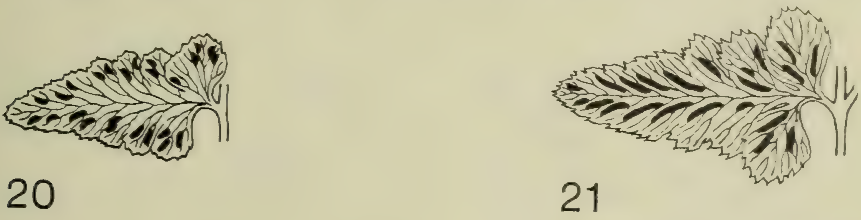
in frond shape somewhat closer than the other example (GV 100:1A, PLATE 3:A, FIGS 10 & 18) to the *scolopendrium* parent. It is very likely that this difference has its origin in heterozygosity in the *adiantum-nigrum* parent, since considerable variation in morphology was found amongst 'selfed' progeny of this plant (FIG. 11). The spore source used was a wild plant which had been brought into cultivation.

Both hybrids are very distinct from the series of *Asplenium billotii* × *Phyllitis scolopendrium* hybrids, and display all those characteristics, i.e., the deltate (as opposed to decrescent) front shape, and the long sori, placed nearer to the midrib than to the margin of the pinna (cf. FIGS 20 & 21), which are recognised (MOORE 1860, GIRARD & LOVIS 1968) to distinguish × *Asplenophylltiis jacksonii* from × *A. microdon*.



FIGURES 20 & 21: Tracings of largest pinnae of × *Asplenophyllitis* hybrids. Natural size. Fig. **20:** *A. billotii* × *P. scolopendrium*, third pinna of JDL 1823. Fig. **21:** *A. adiantum-nigrum* × *P. scolopendrium*, first pinna of GV 100:1A

One hybrid, GV 100:1A, possesses an obvious resemblance to the fronds of × *Asplenophyllitis jacksonii* in the Moore Herbarium from the plants collected by Jackson in Guernsey and Chanter in Devon, on which Moore's *Asplenium adiantum-nigrum* var. *microdon* was based (see above). These two wild examples differ appreciably. The synthetic hybrid (GV 100:1A) provides a link between them, being approximately intermediate with respect to both pinna shape and sorus position, though somewhat nearer to the Jackson plant in pinna shape, and to the Chanter plant in soral placement (Figs 17, 18 & 19). Some immature fronds of another hybrid, JDL 1846, bearing only two or three sori, show a strong resemblance to the frond in the Moore Herbarium from Grève de Lecq, Jersey, which is in similar condition, thus confirming that this wild collection is an example of another rather different form of × *A. jacksonii* (FIGS 15 & 16).

Interpretation of the cytology of the synthetic hybrids in relation to the origin of *Asplenium billotii* and *A. adiantum-nigrum*

Meiosis in our synthetic *Asplenium billotii* × *Phyllitis scolopendrium* hybrids showed 31–36 bivalents and 46–36 univalents. Nearly all of the univalents are disproportionately large in comparison with the bivalents. This remarkable

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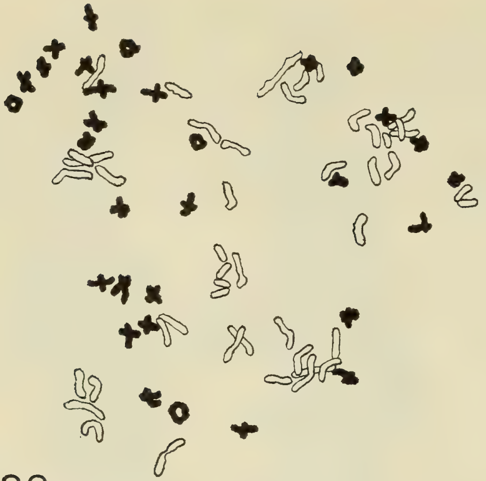
FIGURES 13 – 19: Silhouettes of fronds of × *Asplenophyllitis*. Half natural size. Figs **13**, **15** & **18**: of synthetic hybrids raised at Leeds. Figs **14**, **16**, **17** & **19**: of fronds in Herb. Moore at Kew. Fig. **13**: *Asplenium billotii* × *Phyllitis scolopendrium*, JDL 1823. Fig. **14**: Lectotype of × *Asplenophyllitis microdon* (T. Moore) Alston, Guernsey, 1855, C. Jackson. Fig. **15**: *A. adiantum-nigrum* × *P. scolopendrium*, JDL 1846. Fig. **16**: × *A. jacksonii*, Grève de Lecq, Jersey, 1863. Fig. **17**: Lectotype of × *Asplenophyllitis jacksonii* Alston, ex Devon 1856, cult. 1859, J. M. Chanter. Fig. **18**: *A. adiantum-nigrum* × *P. scolopendrium*, GV 100:1A. Fig. **19**: × *A. jacksonii*, ex Guernsey 1856, cult. 1859, Jackson.



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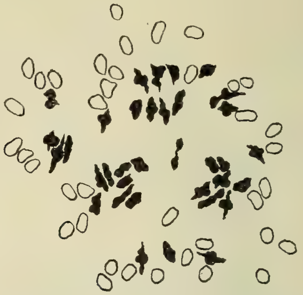

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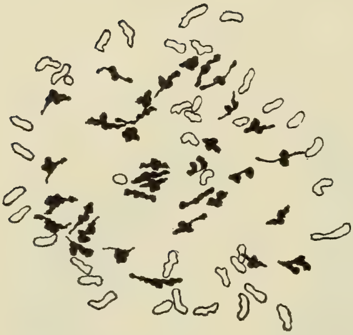

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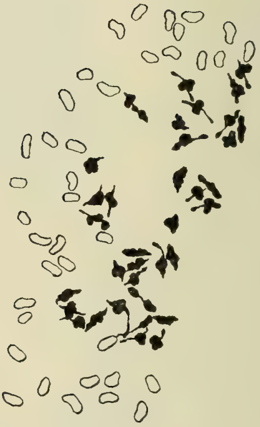

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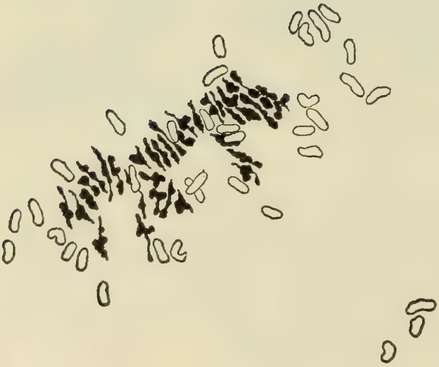

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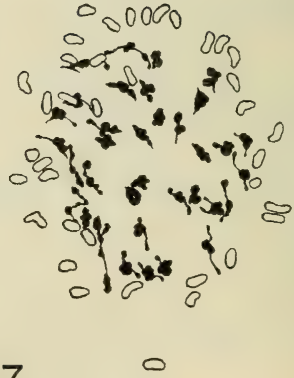

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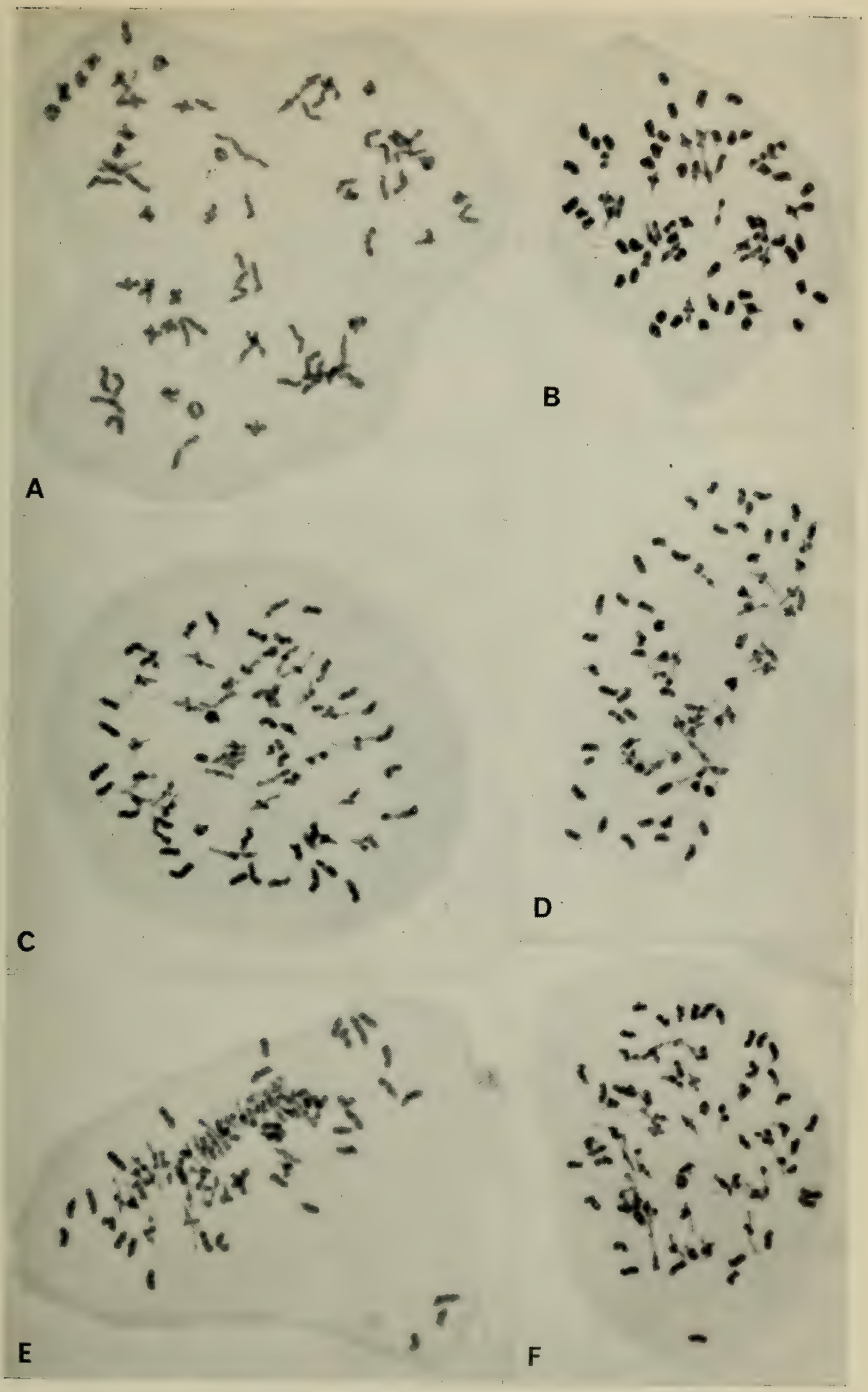

PLATE I: Meiosis in synthetic *Asplenium billotii* × *Phyllitis scolopendrium*. Leitz N.A. 1.4 2 mm apochromat with X10 eyepiece, magnification × 1000. **A & C:** JDL 1821A. **A:** diakinesis, 31 bivalents & 46 univalents. **C:** metaphase (spread), 34 bivalents & 40 univalents. **E:** JDL 1823, metaphase, bivalents in alignment along equator of spindle, 36 bivalents & 36 univalents. **B, D & F:** GV 108, all metaphase with 35 bivalents & 38 univalents, but showing different degrees of contraction of the bivalents.

size relationship is highly informative, since it is now well recognised that there is a distinct difference between the size of the chromosomes of at least a considerable proportion of the species of *Asplenium* and those of *Phyllitis scolopendrium*, which are much larger (MANTON 1950: Figs 95A, 95B, 123E; GIRARD & LOVIS 1968: Plate 1A, 1C). It is also demonstrated very clearly in *A. lepidum* × *P. scolopendrium* (VIDA 1966), where all the chromosomes remain unpaired, but 36 of the univalents are obviously longer than the remaining 72. It is therefore possible to state with confidence that the bivalents present in our *A. billotii* × *P. scolopendrium* hybrids are formed between chromosomes of the two genomes from *A. billotii*. From this demonstration that the two genomes in the reduced complement of *A. billotii* are capable of pairing virtually completely with one another it follows that *A. billotii* is of autopolyploid[4] origin, a conclusion already formulated by SLEEP (1966) on the basis of chromosome pairing found in other synthetic hybrids involving *A. billotii*.

The meiotic pairing behaviour of the chromosomes in our *Asplenium adiantum-nigrum* × *Phyllitis scolopendrium* hybrids is strikingly different from that in the *A. billotii* × *P. scolopendrium* hybrids, since they show almost complete failure of chromosome pairing, although a small number of bivalents (1–6) is found in some cells. For the same reason as in the *A. billotii* × *P. scolopendrium* hybrids (see above), the size of the chromosomes participating in synapsis indicates that the bivalents are formed by pairing between chromosomes contributed by the *Asplenium* parent. However, in all cells studied the great majority of the chromosomes of the two genomes from *A. adiantum-nigrum* remain unpaired. This behaviour is clear evidence indicating an allopolyploid origin for *A. adiantum-nigrum*. The number of bivalents seen in our hybrids (0–6, of a possible maximum of 36) is too few to invalidate this conclusion. Our evidence thus supports the opinion of Dr M. G. Walker (née SHIVAS 1956) that *A. adiantum-nigrum* is an allopolyploid. The evidence obtained by Walker from a complete series of three synthetic hybrids between *A. adiantum-nigrum*, *A. cuneifolium* Viv. and *A. onopteris* L. (the latter two are diploid species) demonstrated unequivocally that if *A. adiantum-nigrum* was of allopolyploid origin, then its parents must be *A. cuneifolium* and *A. onopteris*. Since our evidence demonstrates that *A. adiantum-nigrum* is indeed an allopolyploid[5], it follows that Walker's interpretation (that *A. adiantum-nigrum* is an allotetraploid derived from *A. cuneifolium* × *onopteris*) must be correct.

The status of *Phyllitis*

Natural hybrids have been found between *Phyllitis scolopendrium* and four species of *Asplenium*, namely *A. adiantum-nigrum*, *billotii*, *lepidum*, and *tricho-*

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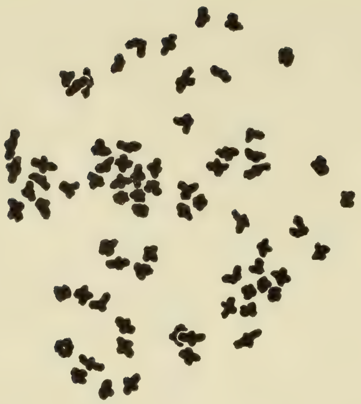
[4] Like Sleep, we use the term autopolyploid in its wider application, meaning derivation from a single diploid species. We do not mean to exclude the possibility of the participation of hybridisation in the origin of *A. billotii*, but we contend that such hybridisation, if indeed involved, was *intra*specific rather than *inter*specific in character.

[5] MEYER's reports (1952, 1957, 1962) of the existence of a diploid form of *A. adiantum-nigrum*, thus introducing the possibility of autopolyploid origin for the common tetraploid plant, has just been withdrawn (MEYER 1968). In this same paper, published while our manuscript was in preparation, Meyer has published corroborative evidence indicating allopolyploidy in *A. adiantum-nigrum*. He reports, although without details or illustration, that the wild hybrid *A.* × *brissaginense* D. E. Meyer (= *A. adiantum-nigrum* × *forisiense* Le Grand) shows complete failure of chromosome pairing (p. 104, 'Das *Asplenium* × *brissaginense* . . . zeigt keinerlei Chromosomenpaarung.').

FIGURES 22 – 27: Explanatory diagrams to cells illustrated on Plate I. Bivalents in solid black, univalents in outline. Magnification × 1000. All *A. billotii* × *P. scolopendrium*.



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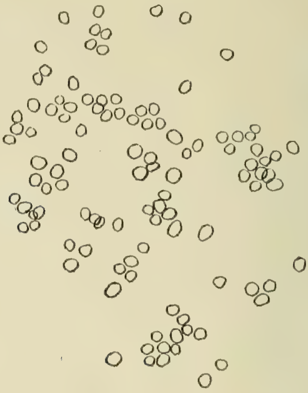

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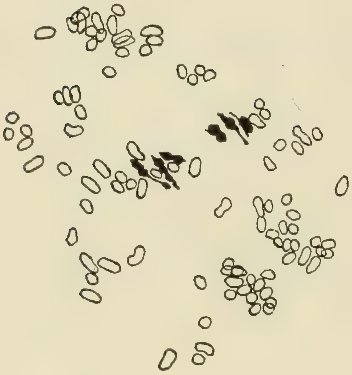

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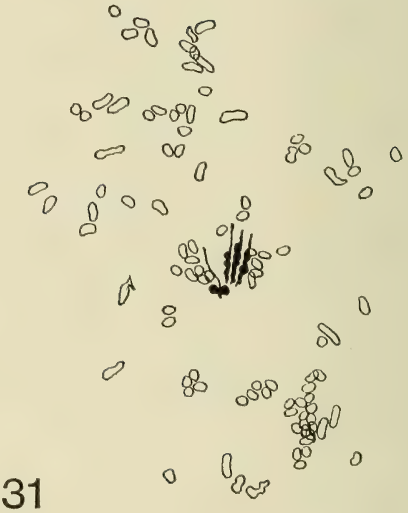

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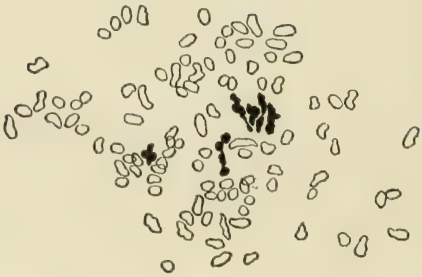

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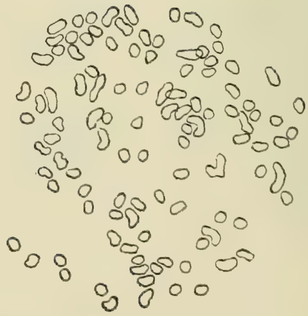

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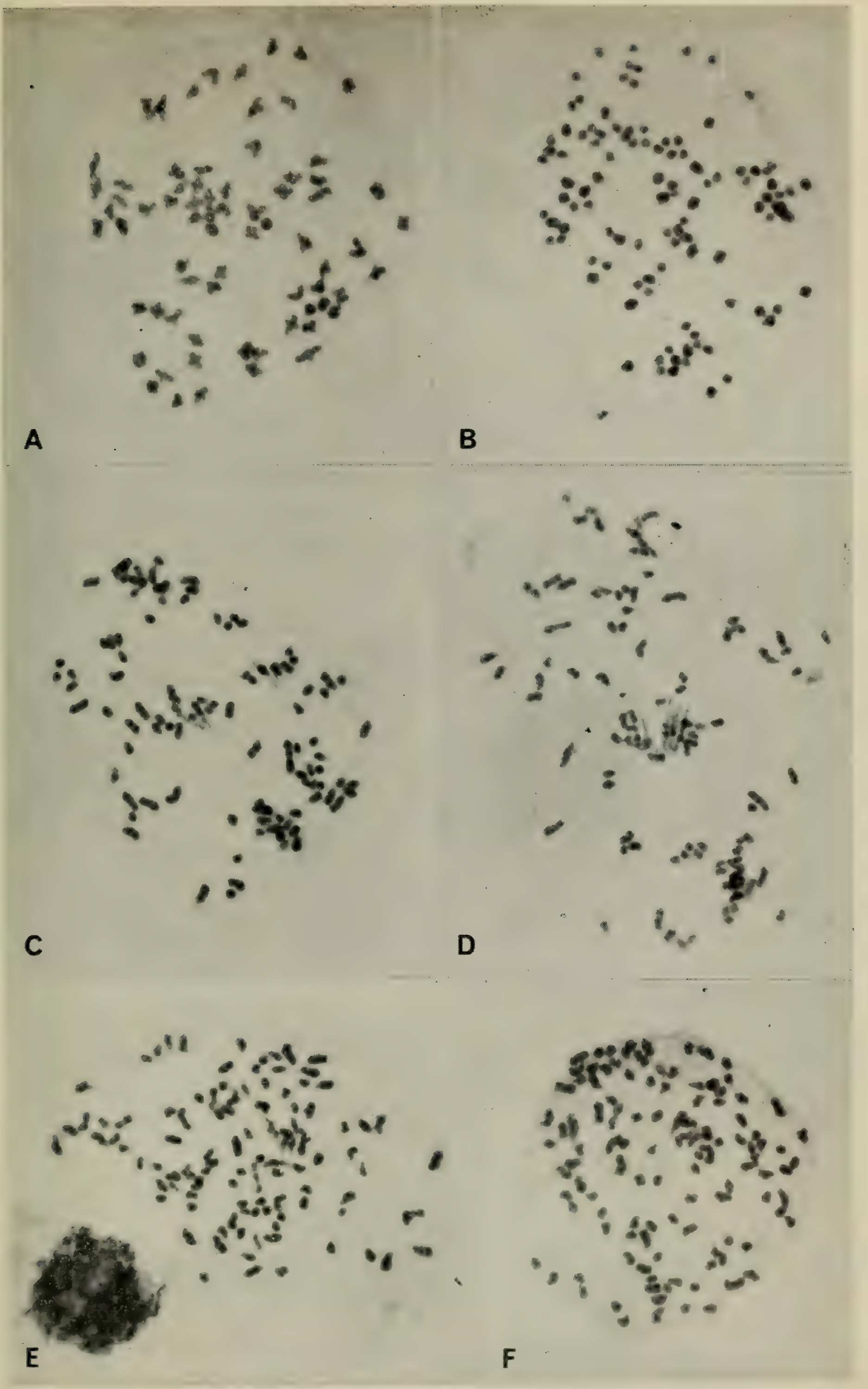

PLATE II: **A:** Meiosis in *A. adiantum-nigrum* ex Kynance Cove, diakinesis with 72 bivalents. **B, C, D, E & F:** Meiosis in *Asplenium adiantum-nigrum* × *Phyllitis scolopendrium*. **B, C & D:** GV 100:1A. **E & F:** JDL 1846. **B & F:** 108 univalents. **D:** 4 bivalents & 100 univalents. **C & E:** 6 bivalents & 96 univalents. Magnification × 1000, Leitz N.A. 1.4 2 mm apochromat with X10 eyepiece.

manes. The identities of the first three of these combinations have been confirmed by synthesis in culture. This confirmation of the existence of a number of natural hybrids between species of *Asplenium* and *Phyllitis* demonstrates that these two genera are not completely genetically isolated. Intergeneric hybrids are surely an anachronism. It is therefore desirable that *Phyllitis* should be merged within *Asplenium.* Such a course of action has already been proposed by COPELAND (1947) on purely morphological grounds[6], by LAWALREE (1950), VIDA (1963), and endorsed most recently by JERMY (1968, p. 51). The appropriate treatment is for *Phyllitis* to be relegated to the status of a section or subgenus within *Asplenium.* For exactly comparable reasons, *Ceterach* (VIDA 1963, & unpub.), *Camptosorus* (SLOSSON 1902, WAGNER 1953, 1954, WAGNER & WHITMIRE 1957), and *Pleurosorus* (LOVIS, unpub.) should all be treated similarly, since each one of them is either known to hybridise with *Asplenium* in nature, or can at least be induced to do so in culture.

In the preceding sections of this paper, the separate generic status of *Asplenium* and *Phyllitis*, and the existence of a hybrid genus × *Asplenophyllitis*, have been recognised. We have done this not because we regard this as a taxonomically proper course of action, but instead as a matter of expediency, since it was clearly desirable to retain some consistency in usage. It was obviously more convenient for the reader for us to use exactly the same names applied by GIRARD & LOVIS (1968). To have departed abruptly from the nomenclature of Alston might have caused some unnecessary confusion. However, nomenclatural usage must evolve in keeping with advance in genetic as well as taxonomic knowledge, and we propose to abandon use of the generic name *Phyllitis*, and × *Asplenophyllitis*. The two hybrids which are the main subject of this paper must then be treated as interspecific hybrids within *Asplenium.*

We give below the revised names for the British representatives of this group of hybrids:—

Asplenium × *confluens* (Moore ex E. J. Lowe) Lawalrée, Fl. Gén. Belg. Ptérid.: 178 (1950).
  Basionym: *A. trichomanes* var. *confluens* T. Moore ex Lowe, Our Native Ferns, **2**: 207, f.560 (1867).
  Synonym: × *Asplenophyllitis confluens* (T. Moore) Alston, Proc. Linn. Soc. Lond. **152** (2): 139, f.2A (1940).
Asplenium × *jacksonii* (Alston) Lawalrée, Fl. Gén. Belg. Ptérid.: 179 (1950).
  Basionym: *A. adiantum-nigrum* var. *microdon* T. Moore, Brit. Ferns, octavo ed. 2: 76, 89 (1860).
  Synonym: × *Asplenophyllitis jacksonii* Alston, Proc. Linn. Soc. Lond. **152** (2): 142, f.2D (1940).
Asplenium* × *microdon (T. Moore) Lovis & Vida **comb. nov.**
  Basionym: *A. marinum* var. *microdon* T. Moore, Ferns of Gr. Brit. & Ireland: t.38 (1855).
  Synonyms: *A. lanceolatum* var. *microdon* (T. Moore) T. Moore, Handbk. Brit. Ferns, ed. 3: 166, f.b (1857).
  × *Asplenophyllitis microdon* (T. Moore) Alston, Proc. Linn. Soc. Lond. **152** (2): 140, f.2B (1940).

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[6] Some species of *Asplenium* (*e.g., A. ruta–muraria, A. septentrionale*) sometimes show sori which are clearly "scolopendrioid" (COPELAND 1947). On the other hand certain species of *Phyllitis* (*P. hemionitis, P. hybrida*) often show some "asplenioid" sori. In fact, it is difficult to find a single key character to separate the two genera which holds true for every species.

FIGURES 28 – 33: Explanatory diagrams to cells illustrated on Plate II. Bivalents in solid black, univalents in outline. Magnification × 1000. Fig. **28**: *A. adiantum-nigrum.* Figs. **29–33**: *A. adiantum-nigrum* × *P. scolopendrium.*

(× *Asplenophyllitis claphamii* (T. Moore) Alston, Proc. Linn. Soc. Lond. 152 (2), 141, f.2C (1940) should certainly be removed from the List of British Vascular Plants (DANDY 1958), since it arose in cultivation and has never been found in nature. Of uncertain status and unknown origin, it is very doubtful whether this plant is strictly entitled to a separate binomial name. See the International Code of Nomenclature for Cultivated Plants (1961), Regnum Vegetabile 22, Utrecht.)

ACKNOWLEDGEMENTS

We thank Professor I. Manton, Professor T. Reichstein, and Mr P. J. Girard for their help and interest, and the Editors of the 'Gazette' for assistance with literature and nomenclature. We also thank the staff of the Experimental Gardens of the Department of Botany in the University of Leeds, and especially Mr Peter Lee and Mr Frank Horwood for their skilful care and attention in looking after our prothallial cultures and the resultant hybrids. We further wish to thank the Scientific Research Council for the award of a Senior Visiting Fellowship to one of us (G.V.), which enabled him to work in Leeds.

SUMMARY

The two hybrids *Asplenium billotii* × *Phyllitis scolopendrium* and *A. adiantum-nigrum* × *P. scolopendrium* have been synthesised, and are found to correspond morphologically very closely with the wild hybrids × *Asplenophyllitis microdon* (T. Moore) Alston and × *A. jacksonii* Alston respectively.

Meiosis in synthesised *Asplenium billotii* × *Phyllitis scolopendrium* is indistinguishable from that in the wild × *Asplenophyllitis microdon.* 31–36 bivalents are found, formed between the two genomes contributed by the *A. billotii* parent. Meiosis in synthesised *A. adiantum-nigrum* × *P. scolopendrium* is very different, only 0–6 bivalents being present. Cytological study of meiosis in these two synthesised triploid hybrids thus confirms that *A. billotii* is of basically autopolyploid origin, and provides direct evidence that *A. adiantum-nigrum* is an allopolyploid.

The significance of the existence of natural hybrids between *Asplenium* and *Phyllitis* is discussed. It is recommended that *Phyllitis*, together with *Camptosorus*, *Ceterach*, and *Pleurosorus*, be included within *Asplenium* with the status of subgenera or sections, and that the hybrid genus × *Asplenophyllitis* be abandoned. A hybrid binomial within *Asplenium* (*A.* × *microdon*, comb. nov.) is given for *A. billotii* × *scolopendrium*.

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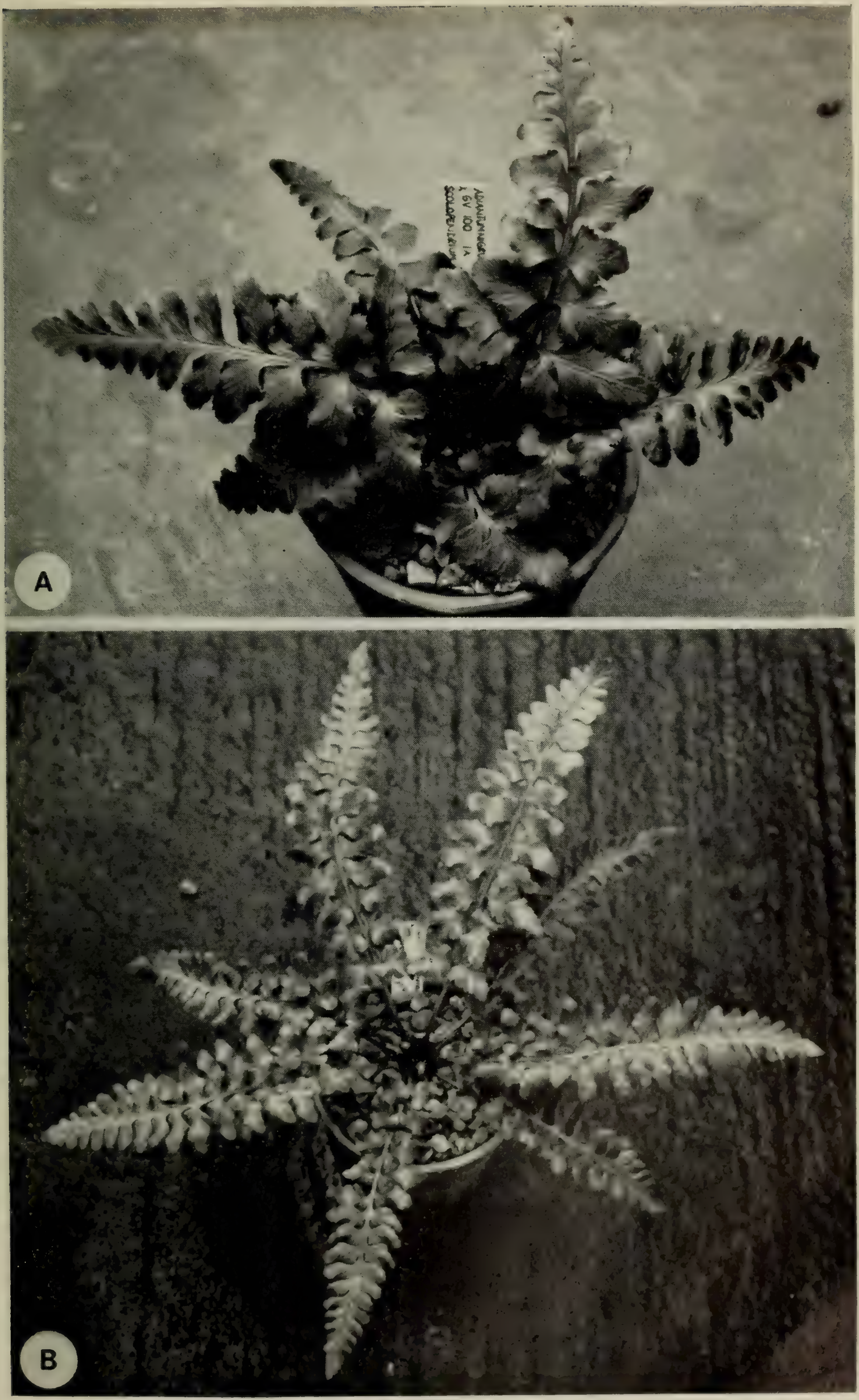

PLATE III: **A:** *Asplenium adiantum-nigrum* × *Phyllitis scolopendrium*, GV 100:1A. **B:** *A. billotii* × *P. scolopendrium*, JDL 1821A. The white labels are ½ inch wide.

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APPENDIX

Cultures used in hybridisation experiments

*Asplenium billotii**,[1]: Ronco, L. Maggiore, Ticino, Switzerland; coll. T. Reichstein, 1960.
A. adiantum-nigrum (1)[2]: Kynance Cove, Lizard, Cornwall; coll. J.D.L., 1962.
(2)[2]: Predannack Manor Farm, Lizard, Cornwall; coll. J.D.L., 1962.
(3)[2]: Lizard Town, Cornwall; coll. J.D.L., 1962.
(4)[3]: Pákozdvár, Velence Hills near Székesfehérvár, Hungary; coll. G.V., April 1963. (GV Aa 4).
(5)[3]: Mount Badacsony, near Lake Balaton, Hungary; coll. G.V., November 1961 (GV Aa 3c).
Phyllitis scolopendrium (1)[4]: Bardsey, Yorkshire; coll. J.D.L., 1966.
(2)[3]: Szuado valley in Mecsek mountains near Pécs, southern Hungary; coll. G.V., August 1961. (GV Phs 2c).

(3)[3]: Lusta valley in Bükk mountains near Miskolc, northern Hungary; coll. G.V., September 1961. (GV Phs 3c).

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*The taxonomy of the *Asplenium billotii*/*obovatum* complex was in a confused state for many years, and is still not completely resolved (MANTON & REICHSTEIN 1962; CRABBE, JERMY, & LOVIS 1964; GIRARD & LOVIS 1968; also SHIVAS, this Journal p. 68). Plants of the Swiss strain of *A. billotii* used in our hybridisation experiments have been raised together with a strain established from spores gathered at the Wasigenstein, Alsace, the *locus classicus* for *A. billotii,* under the same conditions of cultivation (LOVIS & REICHSTEIN, unpub.). The resemblance between these two strains is very close (FIGS 2 & 4), indicating that the Ronco culture belongs to the true *A. billotii* F. W. Schultz.

[1-4]Spore sources: [1]stock raised from spores at Leeds, [2]wild plant maintained in cultivation at Leeds, [3]wild plant maintained in cultivation in Budapest, [4]fronds gathered in wild.

A CYTOTAXONOMIC STUDY OF THE *ASPLENIUM ADIANTUM-NIGRUM* COMPLEX

M. G. SHIVAS (Mrs TREVOR WALKER)*

INTRODUCTION

The cytological results obtained by MANTON (1950) demonstrated that typical *Asplenium adiantum-nigrum* L. was tetraploid, forming 72 bivalent chromosomes at meiosis, whilst another plant which was quoted as *A. adiantum-nigrum* var. *acutum* (Bory) Pollini proved to be diploid. The latter is now almost universally accorded specific rank as *A. onopteris* L. and this name will be adopted here.

It was this demonstration that *A. adiantum-nigrum* sensu lato consisted of more than one cytotype which led to an attempt being made to analyse the inter-relationships of what was obviously a species-complex.

During the course of the investigation the scope of the enquiry was widened to include some members of the *A. obovatum* complex. This has posed certain problems and has made necessary the description of a new species. For these reasons it has been found most convenient to present the work in two sections, the first dealing with the *A. adiantum-nigrum* complex proper and the second section dealing with the inter-relationships of the *A. adiantum-nigrum* and *A. obovatum* complexes.

PART 1 THE *ASPLENIUM ADIANTUM-NIGRUM* COMPLEX

A. adiantum-nigrum sensu stricto is widely distributed in Europe except for the extreme northern and eastern regions (CRABBE, JERMY AND LOVIS, 1964) and also occurs sporadically in North America, Africa and Asia. Living material was available from all these areas other than Asia (see Appendix I) and all specimens, without exception, proved to be tetraploid with n=72.

Similarly, *A. onopteris*, which is widespread in Europe (although tending to have a somewhat more restricted and southerly distribution than *A. adiantum-nigrum*) was sampled from several parts of its range and it consistently proved to be diploid with n=36. In addition, the original Madeiran material quoted by Manton was also available for study.

At an early stage in the investigation *A. cuneifolium* Viv. was incorporated into the programme because of its morphological similarities to *A. adiantum-nigrum* —a feature which is reflected in its earlier name of *A. adiantum-nigrum* var. *obtusum* Willd. This variable plant is diploid and is more restricted in its distribution than either of the preceding species, favouring serpentine areas in the more central and southerly parts of Europe.

Reciprocal crosses were made between these three species in all combinations using material from many different localities (Appendix I) and the chromosome homologies of the hybrids were studied at meiosis.

Hybrids

All the hybrids of a given interspecific cross behaved similarly at meiosis, despite the fact that material both of *A. adiantum-nigrum* and of *A. onopteris* used

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in the hybridization experiments came from localities ranging from a relatively few miles to several thousand miles apart—sometimes, indeed, from different continents. Because of this uniformity of cytological behaviour it is possible to pool the results of all these crosses and present them in summary form in Table I; the full details are given in Appendix II.

In direct contrast to the general uniformity of the behaviour of the chromosomes at meiosis both the morphology and the incidence of heterosis in the hybrids vary greatly according to the parental stocks used. This feature calls for additional comment and is particularly well illustrated in the case of *A. adiantum-nigrum* × *onopteris*.

1. *A. adiantum-nigrum* (4*x*) × *onopteris* (2*x*)

This hybrid combination has been made using stocks of *A. adiantum-nigrum* from places as far apart as Eastern and Western Europe, Africa and N. America and of *A. onopteris* ranging from Turkey to Madeira.

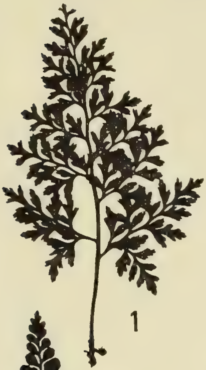
In Europe the morphology of *A. adiantum-nigrum* is very variable (one such type being illustrated in Fig. 2) as is also that of *A. onopteris* (Figs 6 & 7). Despite this there was a marked tendency of the hybrids of European stocks of *A. adiantum-nigrum* to resemble the particular form used very closely (e.g. Fig. 9) with very little trace of the *A. onopteris* parent. Heterosis, on the other hand, varied greatly according to the parental stocks used; thus, when *A. adiantum-nigrum* from Cornwall was crossed with *A. onopteris* from Madeira marked hybrid vigour was evident for the first two years of growth (although not maintained thereafter) whilst the same material of *A. adiantum-nigrum* when crossed reciprocally with *A. onopteris* from Istanbul gave rise to no hybrid vigour at any stage of development.

Outside its European range *A. adiantum-nigrum* has a disjunct distribution. In Africa it is confined to the high mountain ranges in the central and southern regions, being absent from the intervening lowland areas. The morphology of the specimens used in the experiments differed from European material in having wider pinnae and much more conspicuous and finer serrations of the segments. The Transvaal plants in particular were very robust.

Hybrids involving the African material differ considerably in morphology and hybrid vigour according to the particular stock used of both parents. Thus, the morphological characters of Kenyan *A. adiantum-nigrum* predominated in the hybrid with *A. onopteris* from Istanbul and a marked, almost spectacular, hybrid vigour was observed. In direct contrast when the same source of *A. adiantum-nigrum* was crossed with *A. onopteris* from Madeira the hybrids closely resembled the latter parent and little or no heterosis was present.

A similar situation was also shown by the morphologically very different Transvaal material of *A. adiantum-nigrum* when crossed with various sources of *A. onopteris*. Thus, when crossed with *A. onopteris* from Ireland the hybrid had the general appearance of the tetraploid parent and the influence of *A. onopteris* was only to be seen in the finer cut serrations of the segments. By contrast, when *A. onopteris*, from Istanbul was used the hybrid was virtually indistinguishable from this species and showed great hybrid vigour.

It will be seen from these examples that the Istanbul *A. onopteris* reacts quite differently with African material of *A. adiantum-nigrum*, in one case producing hybrids in which the characters of the former species are almost completely dominant and in the other case producing hybrids in which they are recessive.



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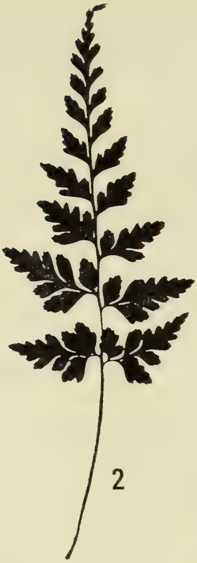

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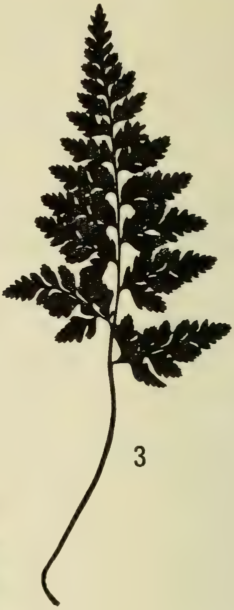

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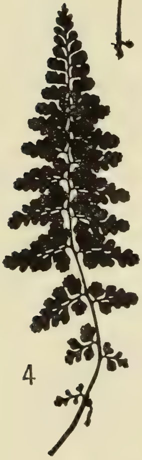

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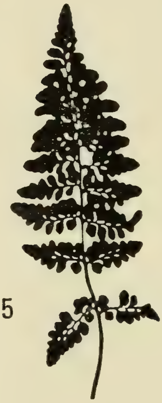

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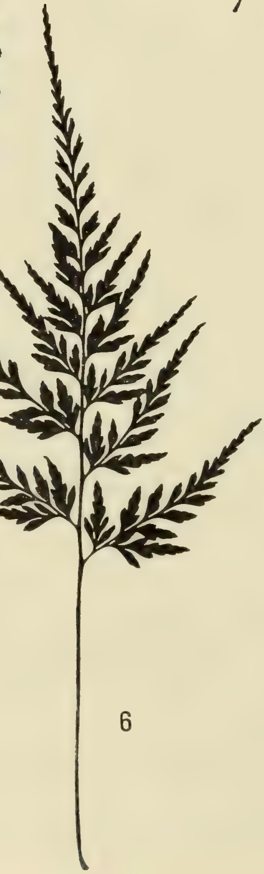

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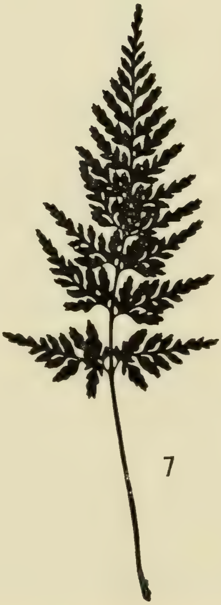

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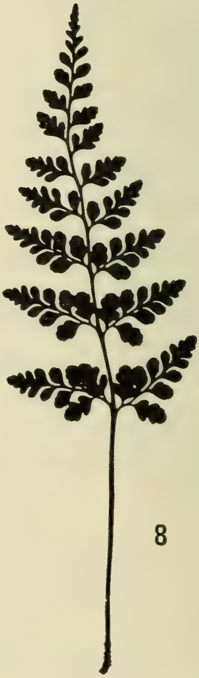

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In North America *A. adiantum-nigrum*, as in Africa, has a disjunct distribution, being recorded from Colorado, Utah, Arizona and possibly from Florida. Such plants are darker green in colour than either the European or the African forms and the pinnae have a slightly crinkled appearance. They do, however, share with the African forms the finer and deeper serrations of the segments than are customarily to be found in European specimens (Fig. 3). The morphological characters of the American material were almost completely dominant in crosses with *A. onopteris*, regardless of the source of the latter parent and heterosis was absent (Fig. 10).

As was indicated in the prefatory remarks all the hybrids involving *A. adiantum-nigrum* and *A. onopteris*, regardless of the sources of the parental material, behaved consistently at meiosis and regularly formed 36 univalents and 36 bivalents (Plate IV B & Fig. 16b).

TABLE 1

Summary of the results of hybridizations involving *A. adiantum-nigrum, A. onopteris and A. cuneifolium*

	Prothalli	Sporophytes	Hybrids	Cytology
TRIPLOID HYBRIDS				
1. (*a*) ♀ *A. adiantum-nigrum* (4*x*) × ♂ *onopteris* (2*x*)	64+	52	17	nI, nII
(*b*) ♀ *A. onopteris* (2*x*) × ♂ *adiantum-nigrum* (4*x*)	115+	80	30	nI, nII
	179+	**132**	**47**	
2. (*a*) ♀ *A. adiantum-nigrum* (4*x*) × ♂ *cuneifolium* (2*x*)	28	13	3	nI, nII
(*b*) ♀ *A. cuneifolium* (2*x*) × ♂ *adiantum-nigrum* (4*x*)	86	39	20	
	114	**52**	**23**	nI, nII
DIPLOID HYBRIDS				
3. (*a*) ♀ *A. onopteris* (2*x*) × ♂ *cuneifolium* (2*x*)	29	19	2	mainly 2nI
(*b*) ♀ *A. cuneifolium* (2*x*) × ♂ *onopteris* (2*x*)	7	2	1	mainly 2nI
	36	**21**	**3**	

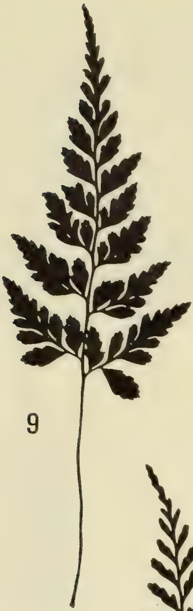
Totals in **bold**: symbols I and II represent univalents and bivalents respectively

2. *A. adiantum-nigrum* (4*x*) × *cuneifolium* (2*x*)

Both European and Kenyan plants of *A. adiantum-nigrum* were successfully crossed with *A. cuneifolium* from Kraubath. Again, as in the previous cross discussed above the extent to which the characters of *A. adiantum-nigrum* were exhibited in the hybrids varied according to the source of the material. Thus, European *A. adiantum-nigrum* produced hybrids which were very similar to this species in general morphology (Fig. 13) whilst hybrids involving Kenyan material were almost exactly intermediate between the two parental types in such features as the shape of the frond, the degree of dissection of the lamina etc.

Again, all these triploid hybrids behaved consistently at meiosis and formed 36 univalents and 36 bivalents (Plate IV D, Fig. 16d).

FIGURES 1–8: Silhouettes of *Asplenium* fronds. All at half natural size. **1:** *A. cuneifolium.* **2:** *A. adiantum-nigrum* (Cornwall). **3:** *A. adiantum-nigrum* (Colorado). **4:** *A. billotii.* **5:** *A. obovatum.* **6:** *A. onopteris* (Madeira). **7:** *A. onopteris* (Istanbul). **8:** *A. balearicum.*



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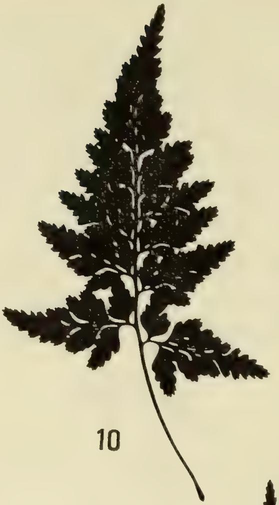

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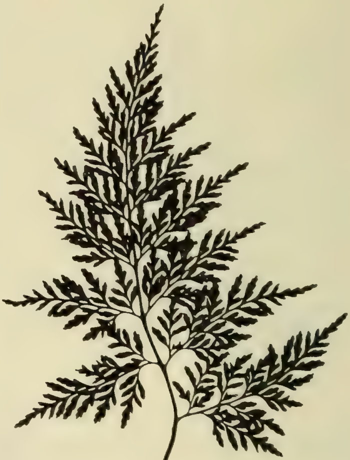

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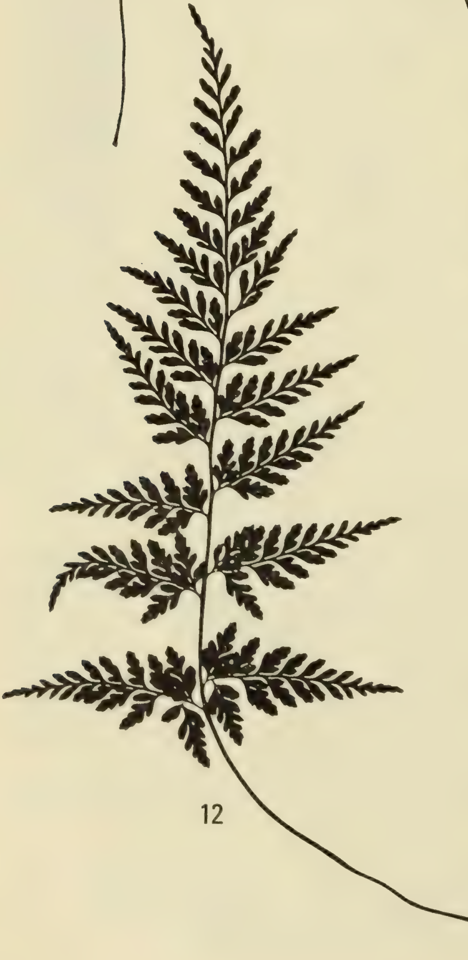

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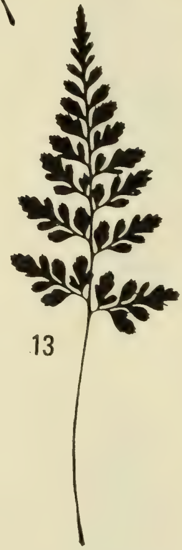

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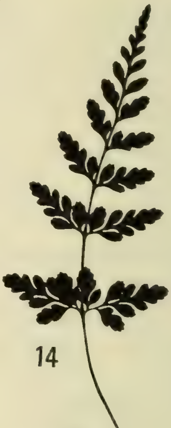
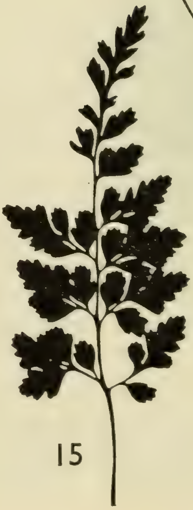


14



15

3. *A. onopteris* (2*x*) × *cuneifolium* (2*x*)

A. cuneifolium was successfully crossed with *A. onopteris* from Cyprus and from Madeira. In both cases the hybrids showed pronounced heterosis, resulting in a very much enhanced rate of growth as compared with the parental stock. The morphology was intermediate between that of the two species involved, showing *cuneifolium* characteristics in the general outline and tripinnation of the frond whilst the *onopteris* parentage was betrayed in the form of the serrations of the pinnules and the caudate ends of the pinnae (Fig. 11).

The behaviour of the chromosomes varied slightly at meiosis even in the same plant. Half the cells showed no pairing whatsoever and thus contained 72 univalents (Plate IV C & Fig. 16c) whilst the other half showed from one up to a maximum of nine bivalents (Plate IV A & Fig. 16a), the remaining chromosomes being unpaired. However, the formation of a few bivalents is not of such a magnitude as to invalidate the general conclusion that there is little homology between the genomes of these two diploid species.

Discussion

The meiotic behaviour of the hybrids reviewed above allows certain conclusions to be reached regarding the inter-relationships of the three species and in particular of the origins of the tetraploid *A. adiantum-nigrum.*

As has already been noted the triploid hybrids formed as a result of crossing *A. adiantum-nigrum* with *A. onopteris* and *A. cuneifolium* all show 36 univalents and 36 bivalents at meiosis. The formation of the bivalents may be due to one of two causes; either by autosyndesis occurring within the *A. adiantum-nigrum* genome if this species is autoploid in origin [cf. *A. septentrionale* L. and *A. ruta-muraria* L. (LOVIS 1964) and *A. petrarchae* Guèr. (SLEEP 1966)] or by allosyndesis taking place between the genome of the diploid species and half the genome of *A. adiantum-nigrum* if the latter is of an alloploid nature.

Until recently no conclusive evidence in favour of one or the other type of origin for *A. adiantum-nigrum* was available but this is now forthcoming, thanks to the efforts of Drs J. D. Lovis and G. Vida to whom I am extremely indebted for allowing me to quote their results whilst their communication is still going through the press (LOVIS & VIDA 1969). These workers have succeeded in synthesising the intergeneric hybrid × *Asplenophyllitis jacksonii* Alston by crossing *A. adiantum-nigrum* with *Phyllitis scolopendrium* (L.) Newm. This hybrid shows an almost complete lack of pairing of the chromosomes at meiosis, thus demonstrating that autosyndesis within the genome of *A. adiantum-nigrum* is not occurring. The conclusion, therefore, is that an autoploid origin for this species can be ruled out.*

Thus the pairing of the chromosomes observed in the triploid hybrids *A.*

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*This conclusion is also supported by the findings of MEYER (1968) who states that *A.* × *brissaginense* D. E. Meyer also shows a complete lack of pairing of its chromosomes. This wild hybrid is diagnosed on morphological grounds as being *A. adiantum-nigrum* × *foresiense.*

FIGURES 9–15. Silhouettes of fronds of *Asplenium* hybrids. All at half natural size. **9:** ♀ *adiantum-nigrum* (Cornwall) × ♂ *onopteris* (Madeira). **10:** ♀ *adiantum-nigrum* (U.S.A.) × ♂ *onopteris* (Madeira). **11:** ♀ *cuneifolium* × ♂ *onopteris* (Madeira). **12:** ♂ *balearicum* × ♀ *onopteris* (Madeira). **13:** ♂ *adiantum-nigrum* (Cornwall) × ♀ *cuneifolium.* **14:** ♀ *adiantum-nigrum* (Ireland) × ♂ *balearicum.* **15:** ♂ *balearicum* × ♀ *obovatum.*

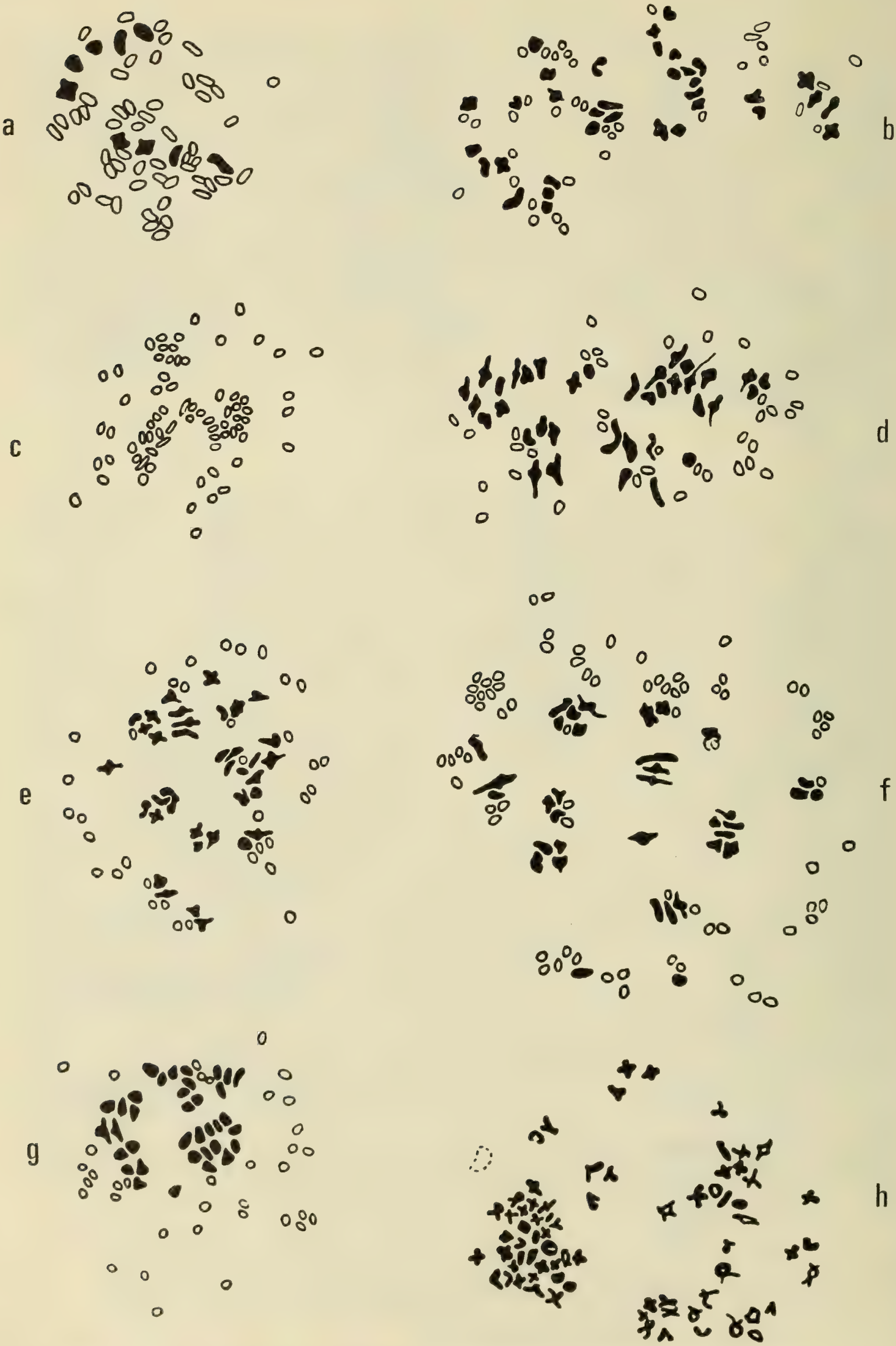

FIGURE 16 a–h: explanatory diagrams to cells illustrated; bivalents (II) in solid black, univalents (I) in outline (see page 75).

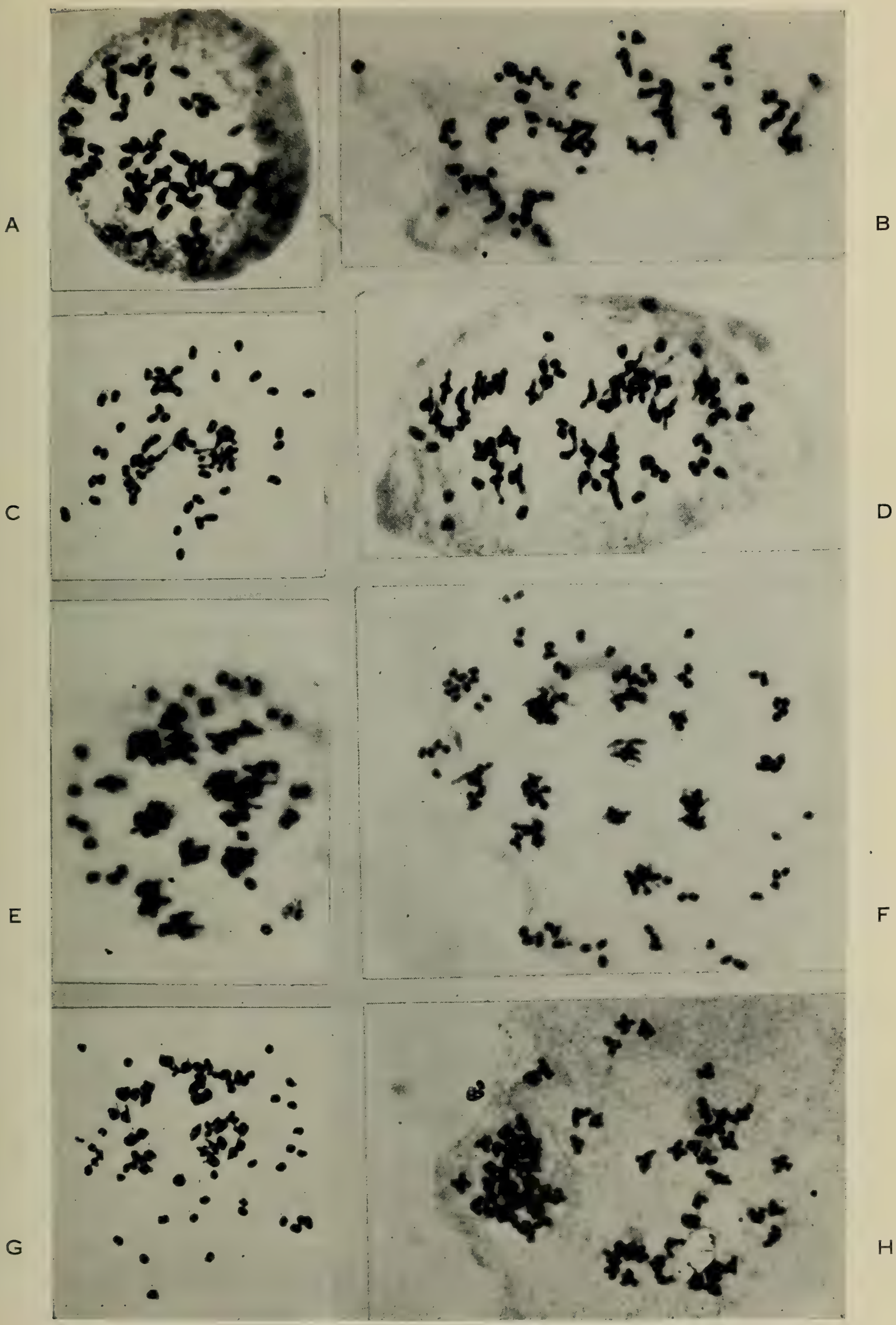

PLATE IV. Permanent aceto-carmine preparations of first metaphase of meiosis. Magnification x 1000.

adiantum-nigrum × *onopteris* and *A. adiantum-nigrum* × *cuneifolium* is taking place between the genomes of the diploid species and half the genome of *A. adiantum-nigrum*. The chromosomes of these ferns are not sufficiently differentiated morphologically to determine by visual examination whether or not it is the same half genome of *A. adiantum-nigrum* which is involved in both cases. However, the almost complete failure of pairing of the chromosomes in the diploid hybrid *A. onopteris* × *cuneifolium* shows that there is little homology between the genomes of these two diploid species and hence in the triploid hybrids with *A. adiantum-nigrum* the genome of *A. onopteris* is homologous with half that of *A. adiantum-nigrum* whilst that of *A. cuneifolium* is homologous with the other half.

All the evidence therefore indicates that *A. adiantum-nigrum* is an allotetraploid which has been derived from the hybridization of *A. onopteris* and *A. cuneifolium*, followed by a doubling of the chromosome number and the restoration of a regular meiosis and fertility.

PART 2

THE *ASPLENIUM ADIANTUM-NIGRUM* AND *A. OBOVATUM* COMPLEXES

During the course of the investigations on *A. adiantum-nigrum* reported above, Miss E. A. O'Nians presented me with four plants which she had collected in the Balearic Islands.

Two of these plants were diploid and were indisputably *A. onopteris* and as such were incorporated into the hybridization programme. The other two plants proved, however, to be tetraploids with n=72 (Plate IV H & Fig. 16h), also Fig. 8. These were somewhat difficult to place taxonomically and were identified by the late Mr A. H. G. Alston as a form of *A. lanceolatum* auct. It was under this name that these plants were incorporated into the breeding programme.

It was subsequently shown that two separate species were included under the name *A. lanceolatum*, these being a diploid (=*A. obovatum* Viv.) and a tetraploid (=*A. billotii* F. W. Schultz). It was concluded, therefore, that the Balearic tetraploids were in fact *A. billotii*. However, it later became evident from work being carried out at Leeds by Drs Sleep and Lovis that genuine *A. billotii* was behaving in a different way to these Balearic plants and this led me to re-examine the specimens in greater detail. It has now become clear that despite superficial resemblances to *A. billotii* they represent a hitherto undescribed species for which I propose the name *A. balearicum*.

Asplenium balearicum Shivas **species nova**

Rhizoma breve erectum, paleis conspicuis, subulatis, brunneis, clathratis, c. 4 mm longis, 1 mm latis, margine projecturis sparsis filiformibus munitis. *Stipites* c. 7 cm longi, castanei, paleis eis rhizomatis similibus sed parvioribus sparse instructi. *Lamina* c. 11 cm longa, c. 5 cm lata, anguste triangularis ad triangularem, bipinnata; rhachidis pars infima per $\frac{1}{2}$ vel $\frac{2}{3}$ longitudinis in pagina abaxiale castanea cetero

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A, a: ♀ *A. cuneifolium* × ♂ *onopteris* (Madeira), showing 9 II and 54 I. B, b: ♀ *A. adiantum-nigrum* (America) × ♂ *onopteris* (Majorca), showing 36 II and 36 I. C, c: ♀ *A. cuneifolium* × ♂ *onopteris* (Madeira), showing 72 I, some of which are drawn out. D, d: ♂ *A. adiantum-nigrum* (Kenya) × ♀ *cuneifolium*, showing 36 II and 36 I. E, e: ♂ *A. balearicum* × ♀ *onopteris* (Madeira), showing 36 II and 36 I. F, f: ♂ *A. adiantum-nigrum* (Kenya) × ♀ *balearicum*, showing 36 II and 72 I. G, g: ♀ *A. balearicum* × ♂ *obovatum* showing 36 II and 36 I. H, h: *A. balearicum*, showing 72 II.

viridis. *Pinnae* usque ad 7 paria, anguste triangulares ad triangulares, etiam imae oblique insertae; pinnulae ovatae vel ellipticae, imae saepe lobatae, summae tantum dentatae, mucronatae, plus minusve herbaceae. *Sori* indusati, ovati, inter costam pinnulae et marginem dispositae. *Sporae* monoletae, 35–45 μm longae, perispora sparsim papillosa, cristis tenuibus saepe anastomosantibus. Chromosomatum numerus n=72; 2n=144; reproductio sexualis.

Type: plant cultivated at Newcastle upon Tyne, raised from spores on plant collected in Balaeric Islands (without precise locality) by Miss E. A. O'Nians, 1952; *Shivas 1968* (Herb. BM, London, **holotype**); Herb. Shivas, isotype. Paratypes: O'Nian's "plant no. 3" (*Alston* 11,834) BM; O'Nian's "plant no. 4" (*Alston* 11,835) BM; offspring of "plant no. 3", (*M. G. Shivas s.n.*, 11 Jan. 1955) BM; all ex Leeds Univ. Bot. Gard.

Rhizome short, erect, furnished with conspicuous brown subulate latticed scales, c. 4 mm long, 1 mm broad, bearing a few filiform projections on the margins. *Stipes* c. 7 cm long, chestnut brown, sparsely bearing scales similar to, but smaller than, those of the rhizome. *Lamina* c. 11 cm long, c. 5 cm wide, narrowly triangular to triangular, bipinnate (see Fig. 8); rachis brown on the lower $\frac{1}{2}$ to $\frac{2}{3}$ of the abaxial side, green elsewhere. *Pinnae* up to 7 pairs, narrowly triangular to triangular, even the lowermost to some extent obliquely inserted; pinnules ovate to elliptical, lowermost often lobed, the upper only dentate, mucronate, more or less herbaceous. *Sori* indusiate, ovate, situated between the pinnule midrib and the margin. *Spores* monolete, 35–45 μm long, perispore sparsely papillate with thin ridges often anastomosing (see Plate V C & D). Chromosome number n=72, 2n=144; reproduction sexual.

The other species with which *A. balearicum* is most likely to be confused are *A. adiantum-nigrum* and *A. billotti/obovatum* and a comparison of the characters of these is set out in Table 2.

TABLE 2

COMPARISON OF THE CHARACTERS OF *A. BALEARICUM* WITH OTHER SPECIES

	A. balearicum	**A. adiantum-nigrum**	**A. billotii/obovatum**
Frond shape	narrowly triangular to triangular	triangular to deltate	narrowly ovate
Pinnae	c. 7 pairs	c. 7–10 pairs	more numerous
Shape of longest pinna	narrowly triangular to triangular	triangular to deltate	ovate
Insertion of pinnae	oblique, towards apex, never deflexed	usually oblique, directed towards apex	some pinnae often deflexed
Position of sorus	between margin and costule	near costule	near margin
Spore length	mean c. 42 μm	mean c. 48 μm	mean c. 35 μm (*obovatum*) mean c. 53 μm (*billotii*)

The spores of these species are very distinctive as may be seen by reference to Plate V A to H. *A. balearicum* and *A. billotii* s.s. not only show a considerable difference in the mean size of their spore (41 μm and 55 μm respectively) but in the sample of 100 spores measured for each specimen there was no overlap, the range being from 35 to 45 μm in the former species and from 48–63 μm in the latter. The spores of *A. adiantum-nigrum* were intermediate in size, ranging from 43 to 58 μm and having a mean length of 48 μm. A further feature of the spores is the

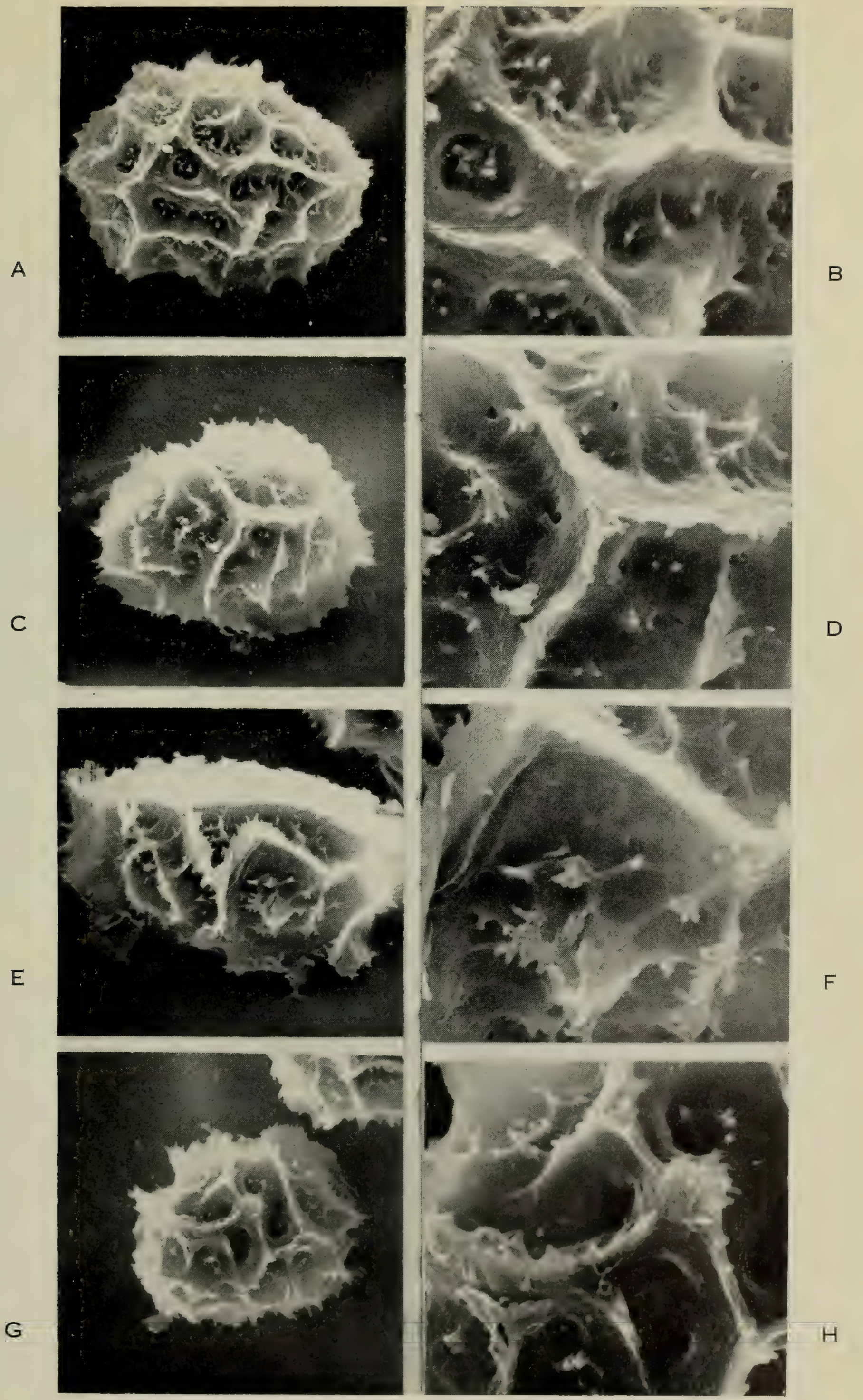

PLATE V. Spore ornamentation in *Asplenium*. Magnification: A, C, E, G x 1000; B, D, F, H x 3000. A, B: *A. adiantum-nigrum*. C, D: *A. balearicum*. E, F: *A. billotii*. G, H: *A. obovatum*.

difference in the size of the surrounding perispore wing which is almost twice as wide in *A. billotii* (c. 5 µm) as it is in *A. balearicum* (c. 2.5 µm). This feature is not immediately obvious in Plate V C to F due to the method of preparing the specimens for viewing under the Stereoscan microscope but is very conspicuous under the light microscope.

Hybrids

A summary of the hybridizations attempted between *A. balearicum* and various members of the *A. adiantum-nigrum* and *A. obovatum* complexes is presented in Table 3.

Three interspecific combinations have been achieved to date, these being the two triploid hybrids *A. balearicum* × *onopteris* and *A. balearicum* × *obovatum* and the tetraploid hybrid *A. balearicum* × *adiantum-nigrum*.

1. *A. balearicum* (4*x*) × *onopteris* (2*x*)

Reciprocal crosses were attempted between *A. balearicum* and *A. onopteris*. When *A. balearicum* was used as the female parent only self-fertilized plants were produced and no hybrids. In striking contrast, however, when this species was used as the male parent 15 sporophytes were produced by only 7 prothalli and every one of them proved to be a hybrid. All showed marked heterosis, especially in the early stages of development, and some resembled *A. balearicum* very closely, whilst others (Fig. 12) were more intermediate, having the general frond outline of *A. balearicum* but with the prominent long caudate tips of the pinnae and greater dissection of the pinnules which are more characteristic of the Madeiran form of *A. onopteris*. There seems little doubt from other evidence that this variable behaviour of the hybrids is due to the heterozygosity of the parents.

At meiosis all these hybrids, regardless of morphology, showed 36 bivalents and 36 univalents (Plate IV E & Fig. 16e). Although the vast majority of the spores were clearly abortive, as might be expected following an irregular meiosis, a few well-filled ones were present although it is not known whether or not they would be capable of germination.

2. *A. balearicum* (4*x*) × *obovatum* (2*x*)

Only one hybrid has resulted from several attempts to make this particular interspecific cross and it only survived for a short time after producing a few sori. Its morphology (Fig. 15) may appear to be somewhat unexpected in that the pinnae segments, for example, are wider than those of either parent (Figs. 8 & 5) but this is somewhat misleading in that many Aspleniums change markedly in morphology with increasing age and maturity.

Despite the early death of this plant a cytological fixation was successfully made and on examination showed 36 bivalents and 36 univalents present at meiosis (Plate IV G & Fig. 16g).

3. *A. balearicum* (4*x*) × *adiantum-nigrum* (4*x*)

A. balearicum performed equally well when used as either the male or the female parent in crosses with *A. adiantum-nigrum*, thus contrasting markedly with its behaviour when crossed with *A. onopteris* as has been noted above.

Although both the Irish and Kenyan forms of *A. adiantum-nigrum* which were used in these crosses differed considerably from one another in morphology all the hybrids were very similar to one another (Fig. 14) and clearly showed the influence of the *A. balearicum* parent in the shape of the frond and pinnae. The latter showed *A. adiantum-nigrum* characters in being less rounded and more coarsely serrated than is the case in *A. balearicum*. None of the plants showed noticeable hybrid vigour.

Cytological examination of all these hybrids showed 36 bivalents and 72 univalents at meiosis (Plate IV F & Fig. 16f).

TABLE 3

Hybridizations between *A. balearicum*, *A. obovatum* and species of the*A. adiantum-nigrum* complex. All *A. balearicum* material is from progeny of the original gathering; see Appendix I for details of source of other material.

FEMALE PARENT	MALE PARENT	RESULTS*
1. *A. balearicum*	*A. adiantum-nigrum* Kenya	(21–16–8)
2. *A. adiantum-nigrum* (2)	*A. balearicum*	(14–4–2)
3. *A. balearicum*	*A. onopteris* Madeira	(14–4–0)
	Majorca	(7–1–0)
4. *A. onopteris* (5)	*A. balearicum*	(7–15–15)
5. *A. balearicum*	*A. cuneifolium* Kraubath	(15–12–0)
6. *A. obovatum*	*A. balearicum*	(8–3–1)

*The number of prothalli used, the number of sporophytes produced and the number of confirmed hybrids, respectively.

Discussion

The cytological analyses of the triploid hybrids showing 36 bivalents and 36 univalents at meiosis is consistent with the hypothesis that *A. balearicum* is an allotetraploid whose parentage involves *A. obovatum* and *A. onopteris*.* These results and conclusions are also in accordance with the formation of 36 bivalents and 72 univalents seen in the tetraploid hybrid, *A. balearicum* × *adiantum-nigrum*, the bivalents being accounted for by pairing of the *A. onopteris* chromosomes which are common to both tetraploid species whilst the univalents represent the genomes of *A. obovatum* and *A. cuneifolium*.

It should, however, be pointed out that in the case of *A. balearicum* (unlike that of *A. adiantum-nigrum*) the final proof of an alloploid origin is still lacking and attempts are being made to supply this deficiency by crossing *A. balearicum* with another totally unrelated species. Such evidence as is available at the present, however, does suggest that *A. balearicum* is indeed an allotetraploid formed by hybridization between *A. onopteris* and *A. obovatum* followed by a doubling of the chromosome complement, and is not of autoploid origins.

ACKNOWLEDGEMENTS

This work was begun in 1950 under Professor I. Manton as part of a programme for the degree of Ph.D. of the University of Leeds and has continued in co-operation with her. I wish to thank her for her constant help and encouragement. At the

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*MANTON & REICHSTEIN (1962), on information supplied by me before the true identity of the O'Nians specimen was realized, concluded in good faith that *A. billotii* was an allotetraploid of *A. obovatum* and *A. onopteris* parentage.

University of Newcastle upon Tyne, the then Head of the Botany Department Professor J. H. Burnett and the present Acting Head, Professor S. L. Ranson kindly allowed me the use of facilities and I am indebted to the gardening staffs of the Botany Departments both of the University of Leeds and of Newcastle upon Tyne for their constant care of the plants. Thanks are due to my husband for his help in preparing the manuscript and to Drs J. D. Lovis and A. Sleep of the University of Leeds and Mr A. C. Jermy of the British Museum (Natural History) for many helpful discussions. The Stereoscan photographs of *Asplenium* spores are due to the kind co-operation of Mrs Margaret Iley and Mr E. H. Boult of the Electron Microscopy Laboratory of the University of Newcastle upon Tyne. Dr W. T. Stearn of the British Museum (Natural History) kindly checked and corrected the latin diagnosis. Finally, my thanks are due to all donors of specimens.

SUMMARY

An account is given of experimental hybridization carried out between members of the *Asplenium adiantum-nigrum* complex. Analysis of the hybrids at meiosis shows that *A. adiantum-nigrum* is a classical allotetraploid formed by hybridization between *A. cuneifolium* and *A. onopteris*, followed by a doubling of the chromosome number.

A. balearicum, a new tetraploid species from the Balearic Islands, is described and an account given of hybridizations carried out between it and members of the *A. adiantum-nigrum* complex, together with *A. obovatum*. Results indicate that *A. balearicum* is an allotetraploid having *A. onopteris* and *A. obovatum* as its diploid progenitors.

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APPENDIX I

Details of the material cytologically examined and used in the hybridization experiments.

Species		Place of origin	Collector	Cytology
A. adiantum-nigrum	1	Cornwall, England	I. Manton	n=72*
	2	Glencar, Co. Kerry, Eire	M. G. Shivas	n=72
	3	Donegal, Eire	L. I. Scott	n=72
	4	Luxembourg	G. Panigrahi	n=72
	5	Mt Kenya, Kenya	E. A. Schelpe	n=72
	6	Transvaal, South Africa	E. A. Schelpe	n=72
	7	Colorado (?), U.S.A.	Fernald	n=72
	8	Colorado, U.S.A.	W. Weber	n=72
	9	Arizona, U.S.A.	Knobloch	n=72
A. onopteris	1	Glencar, Co. Kerry, Eire	M. G. Shivas	n=36
	2	Majorca	E. A. O'Nians	n=36
	3	Istanbul, Turkey	Mrs. Akdik	n=36
	4	Cyprus	F. Merton	n=36
	5	Encumiada, Madeira	I. Manton	2n=72* n=36
A. cuneifolium		Kraubath, Austria	A. H. G. Alston	n=36
A. obovatum		Sardinia	T. Reichstein	n=36†
A. balearicum		Balearics	E. A. O'Nians	n=72

*Manton 1950; †Sleep 1966

APPENDIX II

List of hybridizations between *A. adiantum-nigrum*, *A. onopteris* and *A. cuneifolium*
The source of the parental material used is given in each column (see Appendix I for details). The figures in parenthesis in the right-hand column indicate the number of prothalli used, the number of sporophytes produced and the number of confirmed hybrids respectively.

FEMALE PARENT	MALE PARENT
1. *A. adiantum-nigrum*	*A. onopteris*
(*a*) Cornwall	Madeira (?–12–1), Istanbul (?–7–7)
(*b*) Luxembourg	Eire (8–3–0)
(*c*) Kenya	Majorca (7–5–0)
(*d*) Transvaal	Madeira (6–6–0)
(*e*) U.S.A.	Madeira (7–2–2), Eire (8–2–0), Madeira (14–8–4), Majorca (14–3–3)
2. *A. onopteris*	*A. adiantum-nigrum*
(*a*) Madeira	Cornwall (?–12–0), Kenya (21–9–3), U.S.A. (7–9–0)
(*b*) Istanbul	Cornwall (?–8–8), Kenya (14–7–3), Transvaal (8–8–5), U.S.A. (14–10–5)
(*c*) Eire	Eire (7–7–1), Luxembourg (7–1–1), Transvaal (15–9–3), U.S.A. (22–4–1)
3. *A. adiantum-nigrum*	*A. cuneifolium*
(*a*) Eire	Kraubath (7–2–1)
(*b*) Cornwall	Kraubath (7–3–2)
(*c*) Kenya	Kraubath (7–6–0)
(*d*) U.S.A.	Kraubath (7–2–0)
4. *A. cuneifolium*	*A. adiantum-nigrum*
Kraubath	Eire (8–4–1), Cornwall (7–4–2), Kenya (42–22–17), U.S.A. (29–9–0)
5. *A. onopteris*	*A. cuneifolium*
(*a*) Cyprus	Kraubath (7–2–2)
(*b*) Majorca	Kraubath (8–8–0)
(*c*) Istanbul	Kraubath (14–9–0)
6. *A. cuneifolium*	*A. onopteris*
Kraubath	Madeira (7–2–1)

THE CYTOLOGY OF SOME HYMENOPHYLLACEAE FROM THE SOLOMON ISLANDS

A. F. BRAITHWAITE*

INTRODUCTION

The Hymenophyllaceae is a large family of ferns with some 650 accepted species (8)** which are traditionally divided, mainly on the basis of the structure of the involucre, into the two large genera *Hymenophyllum s.l.* and *Trichomanes s.l.* This treatment is convenient for identification purposes but it does obscure the relationships of the different forms within the two broadly construed and cumbersome genera. Consequently some pteridologists have sought to distribute the numerous species among a number of smaller genera. Copeland (7, 8) recognised a total of 34 genera, accepting many of those of the earlier workers such as Presl and constituting others on his own authority. Copeland regarded most of his subdivisions as natural but his treatment of the family is by no means universally accepted.

The importance of chromosome studies in the Hymenophyllaceae lies in their utility as an additional criterion for assessing the naturalness of Copeland's genera, providing a check on at least some of the subdivisions based on morphology. In addition chromosome numbers may provide valuable evidence for determining the phylogeny of the genera. Although knowledge of the chromosome numbers of the filmy ferns has increased dramatically in recent years (3–6, 10–11, 12–14, 15, 16, 18, 19, 20) only a small part of the family has so far been sampled. Out of the 650 species there are cytological records for nearly 80 species or just over 12% of the total. However, Copeland considered the total number of species accepted in the family as excessive and it is likely the total will be reduced with future taxonomic revisions so that a larger proportion of the family has perhaps been cytologically sampled than the figures suggest. The present report records the chromosome numbers of twenty species found in the Solomon Islands, fourteen of these being recorded for the first time. These will be considered, together with the chromosome numbers already reported in the literature, in relation to Copeland's system of classification.

MATERIAL AND METHODS

The material was collected during the Royal Society Expedition to the British Solomon Islands Protectorate from July to December 1965. The filmy ferns are represented in the fern flora by 30 or more species, many of these being recorded from the islands for the first time during the expedition. Only a proportion of these were found with sporangial material suitable for fixation so that two thirds of the 30 species have been successfully investigated cytologically.

Sporangial material for meiotic chromosome preparations was fixed in the field in acetic-alcohol (1:3) and was later sent by air to the United Kingdom where it was stored in a deep freeze. The chromosome preparations were finally made after the fixings had been stored for six to twelve months. In spite of the excessively humid conditions in the field, with the consequent danger of aqueous contamination of the fixative, and also the lack of any refrigeration facilities during field trips lasting up to 4 or 5 weeks, the fixation was reasonable and yielded acceptable preparations using the acetocarmine squash method.

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**These numbers throughout the text refer to the bibliography on page 91.

Herbarium material of all species recorded here is deposited in the Herbarium at the Royal Botanic Gardens, Kew.

OBSERVATIONS

The chromosome counts of the twenty species of the Hymenophyllaceae which have been determined are recorded in Table I; the species have been listed under headings according to Copeland (8). A total of fourteen genera are represented giving some indication of the variety of form present in the family in the Solomon Islands. The counts for fourteen of the twenty species are new records, including four type species, and there are new cytological records for five of Copeland's genera. These are for *Myriodon*, *Pleuromanes*, *Crepidopteris*, *Callistopteris* and *Nesopteris*.

TABLE I

Chromosome numbers of twenty species of Hymenophyllaceae from the Solomon Islands

Species	RSS No. of collection and locality		Chromosome Number
Mecodium			
bamlerianum (Ros.) A. Braithw.	4414	Kolambangara	n = 36
	4750	Guadalcanal	n = 36
imbricatum (Bl.) Copel.	4749	Guadalcanal	n = 36
treubii (Racib.) Copel.	4456	Kolanbangara	n = 36
Meringium			
gorgoneum (Copel.) Copel.	4316	San Cristobel	n = 21
meyenianum (Presl) Copel.	4748	Guadalcanal	n = 21
Myriodon			
brassii (C. Chr.) Copel.	4416	Kolambangara	n = 21
Vandenboschia			
maxima (Bl.) Copel.	4713	Guadalcanal	n = 36
Pleuromanes			
pallidum (Bl.) Presl	4315	San Cristobal	n = 36
	4326	San Cristobal	n = c. 36
Gonocormus			
saxifragoides (Presl) v.d.B.	4333	San Cristobal	n = 36 (Sexual)
prolifer (Bl.) Prantl	4741	Guadalcanal	2n = 72 (Apogamous)
Crepidopteris			
humilis (Forst.) Copel.	4178A	San Cristobal	n = 36
Crepidomanes			
bipunctatum (Poir.) Copel.	4177A	San Cristobal	n = 36
	4605	Santa Ysabel	n = 36
Microgonium			
motleyi v.d.B.	4158	San Cristobal	n = 34
Callistopteris			
apiifolia (Presl) Copel.	4100	Guadalcanal	n = 36
Nesopteris			
intermedia (v.d.B.) Copel.	4032	Guadalcanal	n = c. 36
Cephalomanes			
atrovirens Presl	4008	Guadalcanal	n = 32
	4086	Guadalcanal	n = 32
	4603	Santa Ysabel	n = 32
densinervum (Copel.) Copel.	4592	Santa Ysabel	n = 32
	4606	Santa Ysabel	n = 32
javanicum (Bl.) Presl	4313	San Cristobal	n = 32
Selenodesmium			
obscurum (Bl.) Copel.	4033	Guadalcanal	n = 33
	4314	San Cristobal	n = 33
Macroglena			
schlechteri (Brause) Copel.	4677	Guadalcanal	n = 66

Mecodium

A genus represented in the Solomon Islands by three species, *M. bamlerianum* (Ros.) A. Braithw.*, *M. imbricatum* (Bl.) Copel. and *M. treubii* (Racib.) Copel., which all show 36 bivalents at meiosis. Cytological records for nineteen species attributed to this genus exist in the literature (3–5, 10–11, 15, 16, 18, 19, 20). The three Solomon Island species recorded here fall into the dominant cytological series of the genus, with a base number of 6 or 9; the existence of another series, based on 7, suggests the genus as construed by Copeland may not be a natural one (cf. 20).

Meringium

This genus is probably one of the most cytologically variable of Copeland's genera although this may partially be a reflection of the small number of species for which chromosome counts are available. Only four species have been previously recorded and these reveal a striking range of variation. *M. meyenianum* (Presl) Copel. from Malaya has $n=21$ (15), *M. bivalve* (Forst.) Copel. $n=22$ (3, 19), *M. multifidum* (Forst.) Copel. $n=26$ (3) and *M. fucoides* (Sw.) Copel. from Jamaica has $n=56$ (20). *M. meyenianum* from the Solomon Islands shows $n=21$ (Plate A) and the only other species successfully counted, *M. gorgoneum* (Copel.) Copel., also shows $n=21$.

The chromosome numbers recorded so far in this genus appear to fall into three separate numerical series. The counts from Malaya and the Solomon Islands of $n=21$ can be interpreted as multiples of 7 and $n=56$ from Jamaica may be a part of the same series. The remaining counts of $n=22$ for *M. bivalve* and $n=26$ for *M. multifidum* would appear to represent parts of two further series, one based on 11 and the other on 13.

Myriodon

The genus *Myriodon* was described with a single species, *M. odontophyllum* Copel., from New Guinea. It is characterised by fronds without any continuous laminar expansion and its replacement by discrete teeth or fragments of lamina attached longitudinally to the frond in all planes. The only other species attributed to the genus is *M. brassii* (C. Chr.) Copel. which is found in New Guinea and the Solomon Islands. This species possesses fronds with more continuous sections of lamina which bear rather unusual reddish trichomes. Although it has not been possible to examine the type specimens involved it seems likely that only one species is involved here *M. odontophyllum* Copel. and the earlier named *M. brassii* (C. Chr.) Copel refers to the same taxon as Copeland's type species.

Cytological examination of *M. brassii* from the summit of Kolambangara in the Solomon Islands produced exceptionally clear preparations showing 21 bivalents (Plate B).

Although Copeland (8) regarded *Myriodon* as a derivative of *Meringium* he justified its removal from *Meringium* on the basis of its bizarre appearance. The two genera are clearly allied morphologically perhaps indicating an unnecessary and arbitary generic distinction. *Myriodon brassii* resembles most closely certain species in *Meringium* with conspicuously toothed or serrated margins, particularly

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****Mecodium bamlerianum*** (Ros.) A. Braithw., ***comb. nov.*** Basionym: *Hymenophyllum bamlerianum* Ros., Fedde Rep. **10:** 323 (1912).

Meringium denticulatum (Sw.) Copel. and to a lesser extent *Meringium meyenianum.* The cytology is in accord with the morphology since the same chromosome number (n=21) is now known in *Myriodon brassii* and *Meringium meyenianum* and in addition the chromosomes of the two species are very similar in size and general morphology (compare Plate A and B).

Vandenboschia

Of the eight species for which cytological information has been recorded (4, 11, 12, 16, 20) all except one *V. scandens* (L) Copel. with n=64 (20), have been reported as having n=36 or a multiple of this number. *V. maxima* (Bl.) Copel. from the Solomon Islands also has n=36.

Pleuromanes

There are no cytological records for this rather distinctive genus of three species which are characterised by glaucous fronds with the costae enclosed by a dilated sclerenchymatous sheath. These sheaths are often very hairy. The most widely distributed species is *P. pallidum* (Bl.) Presl and two representatives of this species from the Solomon Islands have shown 36 bivalents at meiosis and could well have been derived (as Copeland suggests) from *Vandenboschia.*

Gonocormus

Gonocormus is a small Old World genus made up of a number of rather ill defined species which has in the past led to considerable taxonomic and nomenclatural confusion. The genus is represented in the Solomon Islands by two species, *G. saxifragoides* (Presl) v.d.B. and *G. prolifer* (Bl.) Prantl. Sledge (17) has discussed the taxonomic and nomenclatural problems of these two species. The two species are quite distinct both morphologically and ecologically in the Solomon Islands. *G. saxifragoides* is a small compact plant with short non-proliferous stipes each bearing an orbicular flabellately-cut lamina, and was generally found growing as an epiphyte at low altitudes sometimes on trees overhanging the beach. *G. prolifer*, on the other hand, is a larger stiffer plant with a proliferous stipe and rachis and with the divisions of the lamina more pinnate than flabellate. It was seen only once at approximately 6,000 ft. on Mt Popomanatseu forming a continuous carpet on the forest floor and fallen tree trunks in the mist forest. These differences are borne out by the cytology of the two species. *G. saxifragoides* is a sexual species showing 36 bivalents at meiosis (Plate VI C, fig. 1) while *G. prolifer* possesses the same number of chromosomes but they appear as univalents during meiosis (Plate VI D, fig. 2) and it is almost certainly an apogamous species.

Although the spores have not been tested for apogamy there is some very cogent cytological evidence for the apogamous life cycle in *G. prolifer.* The first meiotic division, though appearing normal with paired chromosomes in the early stages, leads to a very characteristic diakinesis and metaphase where the chromosomes appear as 72 univalents. These fail to separate during the first meiotic division and at interphase a restitution nucleus is formed. A normal second meiotic division then follows forming diads instead of tetrads, each member of the diad containing the somatic number of chromosomes. Thus the requirement of the apogamous life cycle for an unreduced chromosome number in the spore to compensate for the absence of sexual fusion is satisfied. This cytological mechanism, although differing in minor details, is essentially the same as that observed in apogamous *Asplenium aethiopicum* (Burm.) Bech. (2) and the apogamous *Polypodium dispersum* Evans (9). The only other cytological record for the genus *Gonocormus* is a count for *G. prolifer* from Sarawak (1). In this material from Gunong Poe, 108 univalents were observed and meiosis was again characterised by an asynaptic diakinesis. As Bell suggested at the time this material was almost certainly apogamous.

It is clear that *G. prolifer* is an apomictic complex with at least two cytological types and is closely related morphologically to the sexual species *G. saxifragoides*. It is, therefore, not surprising that taxonomists have experienced some difficulty in dealing with the variation and defining satisfactory species limits in the genus. This situation is reflected in the number of synonyms attributed to *G. prolifer*, for example 8 are recorded by Sledge (17). It is a noteworthy fact that *G. prolifer* should have developed a highly effective mode of vegetative reproduction as well as the apogamous life cycle.

Crepidopteris

There are no cytological records in the literature for this small Old World genus which is typified by *C. humilis* (Forst.) Copel. The type species is the only representative in the Solomon Islands and has shown n=36.

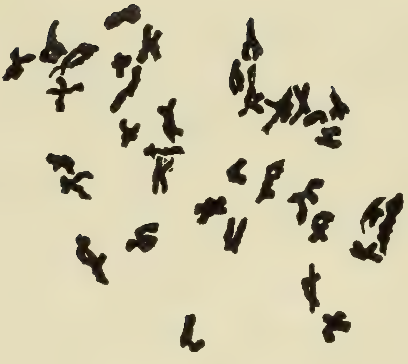
Crepidomanes

The sole representative of *Crepidomanes* from the Solomon Islands, *C. bipunctatum* (Poir.) Copel. shows n=36. All previous cytological records (13, 15, 16, 19, 20) representing six species have also shown n=36 or a multiple of this number.

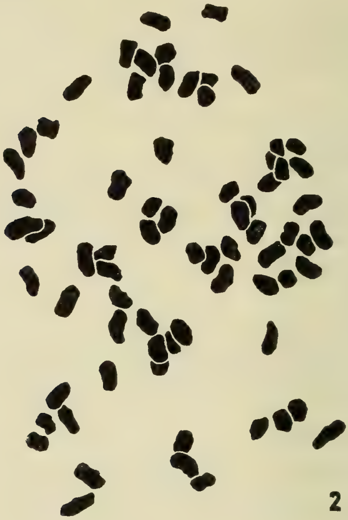
One member of this genus is particularly interesting since, in parallel with *Gonocormus prolifer*, it shows cytological evidence suggestive of apogamy. Mehra & Singh (16) working with material of *C. insigne* (v.d.B.) Fu (formerly included in *C. bipunctatum*) from the Himalayas found in plants they refer to as forma β, spore mother cells at diakinesis with 108 univalents which divided by an abbreviated meiosis to form diads of spores. The chromosome number (2n=108) of forms β compared with the morphologically similar forma χ, possessing normal meiosis with 36 bivalents, led them to suggest that forma β was an asynaptic triploid. The possibility that it might also be apogamous was not considered; however, diad formation would lead to unreduced spores necessary for the apogamous life cycle. *C. bipunctatum* is a rather polymorphic species and it seems not improbable that it is another sexual-apomictic complex of the type already described under *Gonocormus*.

Microgonium

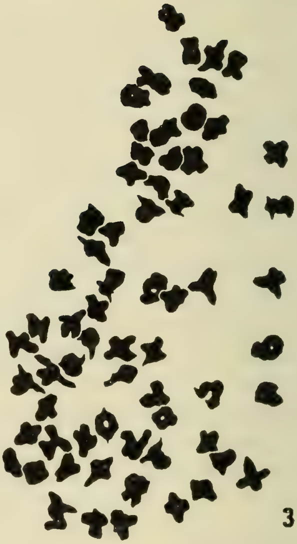
The only Solomon Island representative of this genus which has been studied cytologically is *M. motleyi* v.d.B. which has shown approximately 34 chromosomes at meiosis. This agrees with a count of n=34 for Malayan material of the same species (15). Double this number has been observed in *M. hookeri* Presl (20) and in *M. bimarginatum* v.d.B. (19). From the few cytological records available this genus of exceedingly reduced species has every appearance of being cytologically uniform with 34 chromosomes or a multiple of this number.



1



2



3

FIGURES 1–3. Explanatory diagrams for Plate VI.

1: *Gonocormus saxifragoides* (Plate VI C) with 36 bivalents.

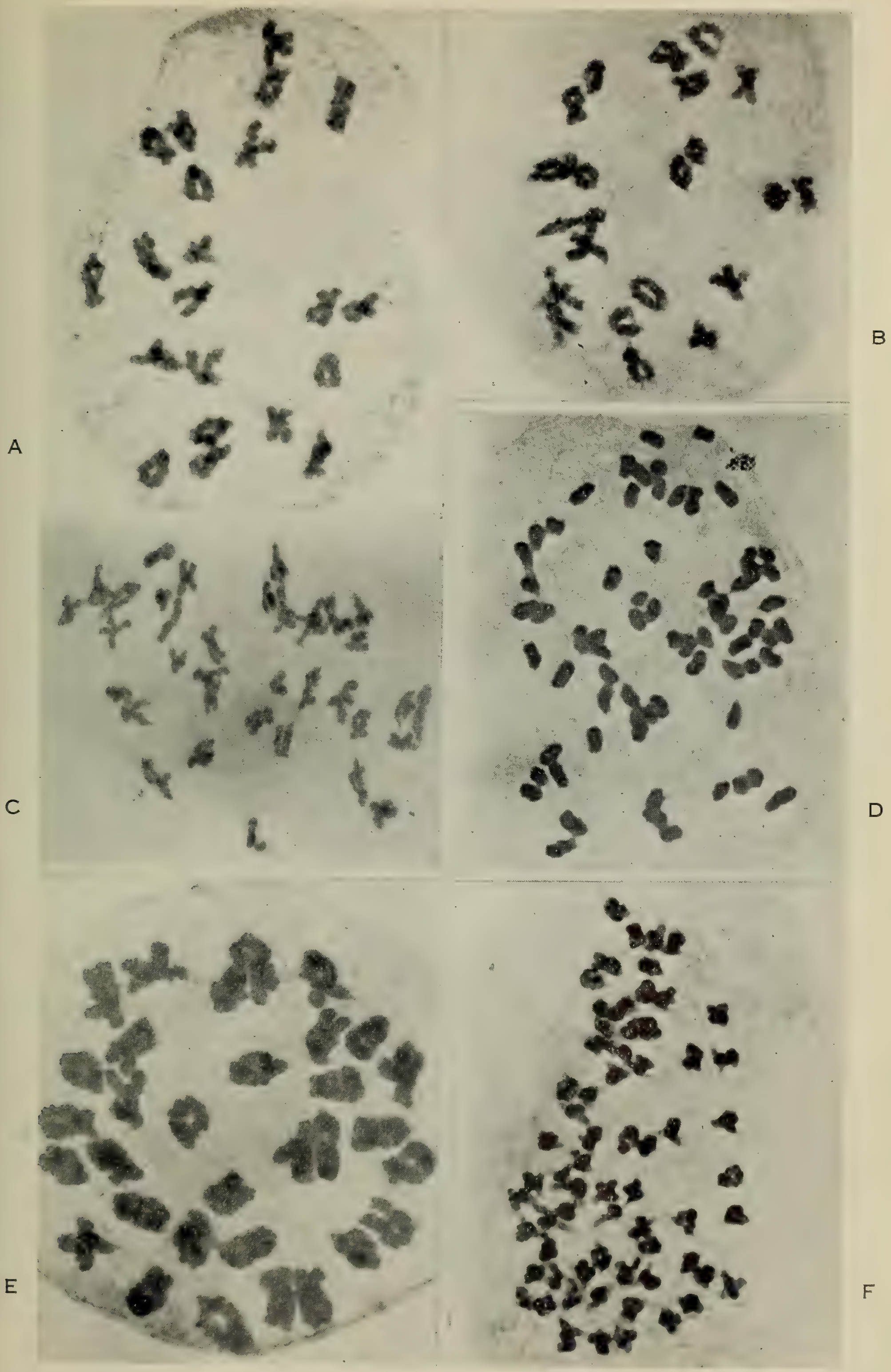
2: *G. prolifer* (Plate VI D) with 72 bivalents

3: *Macroglena schlechteri* (Plate VI F) with 66 bivalents.

PLATE VI: Photographs from permanent acetocarmine squash preparations of spore mother cells in meiosis. Magnification × 1000.

A: *Meringium meyenianum* (RSS4748) with 21 bivalents.
B: *Myriodon brassii* (RSS4416) with 21 bivalents.
C: *Gonocormus saxifragoides* (RSS4333) with 36 bivalents. For explanatory diagram see fig. 1.
D: *Gonocormus prolifer* (RSS4741) with 72 univalents. For explanatory diagram see fig. 2.
E: *Cephalomanes atrovirens* (RSS4008) with 32 bivalents.
F: *Macroglena schlechteri* (RSS4677) with 66 bivalents. For explanatory diagram see fig. 3.

PLATE VI



A chromosome number of n=34 or a multiple thereof is also typical of two New World genera *Didymoglossum* and *Lecanium* (20) which share some major morphological attributes with *Microgonium* but so far it has not been encountered elsewhere in the Hymenophyllaceae. All three genera are groups of small epiphytic plants with minute entire or pinnatifid fronds with false veinlets although there are other morphological characters distinguishing each genus. Copeland (8) did not recognise any close relationship between *Microgonium* and *Didymoglossum* in as far as he derived them quite independently from *Crepidomanes* and *Vandenboschia* respectively. The broad correlation between morphology and cytology perhaps indicates a somewhat closer relationship for all three genera. It is, therefore, suggested that they could represent the remote and divergent ends of a common phyletic line.

Callistopteris & Nesopteris

No previous cytological records exist for either of these small genera which are each represented in the Solomon Islands by a single species. Both *C. apiifolia* (Presl) Copel., the type species of *Callistopteris*, and *Nesopteris intermedia* (v.d.B.) Copel. have n=36. Copeland (8) regarded both these genera to be derived from *Vandenboschia* and in the case of *Nesopteris* he suggested *V. maxima* (n=36), "as a more particular relative of its ancestors!"

Cephalomanes

Cephalomanes is a very distinctive group of Old World species with simply pinnate polystichous fronds typified by *C. atrovirens* Presl described from the Philippines. This species is a widespread and common fern of the lowland forest of the Solomon Islands and three separate gatherings have shown n=32 (Plate E). The genus is also represented in the Solomon Islands by two other species, *T. densinervum* (Copel.) Copel., which was found only on ultrabasic soils and *T. javanicum* (Bl.) Presl, both showing n=32. The only record in the literature is a count of n=c.32 for *T. javanicum* from Malaya (13). Members of this genus form a very natural morphological unit and the naturalness is confirmed by the cytological uniformity of the species which have so far been examined.

Cephalomanes has a cytological counterpart in the New World genera *Trichomanes s. str.* and its derivative *Feea* which also have n=32 or a multiple of this number (20). The three genera are clearly allied morphologically as they are all groups of terrestial rather robust plants with a rhizome tending to become erect and typically giving rise to rather stiff pinnatifid or pinnate fronds. There is, therefore, among these three genera some correlation between their distinctive morphological facies and cytology. Copeland (8) considered *Cephalomanes* and *Trichomanes s. str.* to have been derived independently from *Vandenboschia* stock and their subsequent development to have been parallel in the two regions. At present the only other chromosome number among the Hymenophyllaceae relating directly to a 32 series is n=64 found in *Vandenboschia scandens* (L.) Copel. (20). This suggests n=32 was once present or still exists among species attributed to *Vandenboschia* and that the genus contains two cytological lines, a 32 series and a 36 series. The ancestral stock of the 32 series could well have given rise to *Cephalomanes* and *Trichomanes s. str.*

Selenodesmium

A chromosome number of n=33 has been recorded for three species of this genus, *S. obscurum* (Bl.) Copel. from Malaya (15), *S. cupressoides* (Desv.) Copel. from West Africa (14) and *S. rigidum* (Sw.) Copel. from Jamaica and Trinidad (20). The Solomon Island material of *S. obscurum* also shows n=33. Each of these species are so closely related morphologically that all could perhaps be regarded as a single pantropic species. In addition n=36 has been recorded in *S. elongatum* (A. Cunn.) Copel. from Northern Queensland (19) and *S. dentatum* (v.d.B.) Copel from New Caledonia (6).

Copeland (8) regarded this small genus of 10 species as a natural group but this has not been confirmed by the cytological records. It is interesting to note that the two species with 36 chromosomes are southern representatives and that one of them, *S. dentatum*, is so close morphologically to *S. obscurum* that the two have often been confused.

Macroglena

The only representative of *Macroglena* which has been successfully investigated from the Solomon Islands is *M. schlechteri* (Brause) Copel. giving a count of n=66 (Plate F, fig. 3). This is rather an unusual chromosome number in the family which has not been recorded before but is surely a polyploid based on 33. The only other cytological record for the genus is a count of n=36 for *M. caudata* (Brack.) Copel. from Northern Queensland (19).

The genus *Macroglena* is characterised chiefly by finely dissected fronds with the lamina reduced to very narrow wings on the axes. Copeland (8) in recognising the group admitted the possibility that it was not natural since reduction of the lamina could make species of diverse origin look alike. From the sparse cytological sampling it is already evident that the genus is not natural and that parallel evolution in at least a 33 series and a 36 chromosome series has taken place. It is possible the species with 36 chromosomes represent a line of lamina reduction from *Vandenboschia* stock but in view of its cytology it is unlikely the 66 chromosome species has arisen from a similar source. Copeland (8) commented that there was sure affinity between *Macroglena* and *Selenodesmium* and since chromosome numbers of 33 or a multiple are not very common among the trichomanoid genera as a whole the cytology lends some weight to this view.

The two genera *Selenodesmium* and *Macroglena* appear therefore to represent a mixed phyletic assemblage and are not very satisfactory groups. The two genera have only been sparsely sampled so far and it is clear that further morphological and cytological work is required to ascertain whether a more natural grouping of the species attributed to these genera can be achieved.

GENERAL DISCUSSION

The cytological discrepancies within some of Copeland's genera have become increasingly evident as the number of species sampled increases. Conspicuous in this respect are the hymenophylloid genera *Mecodium*, *Meringium* and *Hymenophyllum* and the trichomanoid genera *Vandenboschia* and *Selenodesmium* to which now may be added *Macroglena*. All the other genera are cytologically uniform on the basis of present information although it is possible, especially with some of the larger genera, that this may merely be a reflection of the sparse cytological sampling in some cases.

The hymenophylloid genera *Mecodium*, *Meringium* and *Hymenophyllum* (the latter has not been dealt with in the foregoing sections because there is no representative in the Solomon Islands) are the most heterogeneous cytologically although there is an element of uniformity in the first two. Fourteen of the nineteen species which have been examined so far in *Mecodium*, including the type species, have a chromosome number of 36 or a multiple. *Meringium* and its derivative *Myriodon* have only been sparsely sampled; the counts, including two for the type species, fall into a numerical series based on 7, apart from two from the far south. *Hymenophyllum* is undoubtedly the most variable and least satisfactory genus from the cytological standpoint. *H. peltatum* Desv. has n=11 (4, 18), *H. tunbrigense* (L.) Sm. and *H. wilsoni* Hook. have n=13 and n=18 respectively (12), *H. revolutum* Col. shows n=22 (4), *H. cupressiforme* Labill. has n=22 (18, 19) and *H. barbatum* (v.d.B.) Bak. shows n=21 (11).

Taking all three genera together the chromosome numbers obtained from direct observations fall into four numerical series viz: 11–22; 13–26; 18–36–72; and 21–28–56. As defined at present *Mecodium* contains parts of two, *Meringium* parts of three and *Hymenophyllum* parts of four of these numerical series. It is, therefore, difficult to believe that the generic boundaries have been properly drawn among the hymenophylloid species. Renewed morphological studies mindful of the cytological series and also of geographical distribution might contribute to a better understanding of the evolutionary lines among these species and eventually prove profitable in attempting to delimit more natural taxa.

The trichomanoid genera present rather a different morphological and cytological pattern from the hymenophylloid species. The more numerous and smaller genera are on the whole better defined morphologically and there is greater cytological uniformity not only within genera but also between groups of morphologically related genera. On the basis of present information they fall into four cytological groups with 32, 33, 34 or 36 chromosomes or a multiple of these numbers Three genera, *Cephalomanes*, *Trichomanes s. str.* and *Feea* fall into the 32 series; three genera, *Microgonium*, *Didymoglossum* and *Lecanium*, fall into the 34 series; and seven genera, *Vandenboschia* (apart from one species), *Pleuromanes*, *Gonocormus*, *Crepidopteris*, *Crepidomanes*, *Callistopteris* and *Nesopteris* fall into the 36 series. The two genera *Selenodesmium* and *Macroglena* are mixed cytologically with 33 and 36 chromosome species. Among these genera cytology is of little use in confirming the generic boundaries within any group but the different chromosome series do tend to circumscribe groups of genera with distinct morphological facies. This is particularly the case with *Cephalomanes*, *Trichomanes s. str.* and *Feea* and also with *Microgonium*, *Didymoglossum* and *Lecanium*.

Copeland (7, 8) gave a central place to *Vandenboschia* in the phylogeny of the trichomanoid genera deriving virtually all the genera except *Selenodesmium* and *Macroglena* from this large pantropic group. The cytology does not disagree with this simple pattern of relationships for that part of *Vandenboschia* with 36 chromosomes and those genera also showing 36 chromosomes, particularly those such as *Callistopteris* and *Nesopteris* where a close relationship is also clearly evident from morphology. The relationships of the remaining cytological groups is a much more open question since the derivation of the chromosome numbers which have been directly observed is largely a matter of speculation in view of the present limited evidence from low chromosome numbers in the family as a whole. Two alternative schemes of chromosome evolution from primitive base numbers have already been put forward by Vessey & Barlow (19) and Walker (20). The scheme of Vessey & Barlow admits only two base numbers of 7 and 11 for the family and favours a monophyletic origin of the trichomanoid species from the amphidiploid secondary base number of n=18. All the chromosome numbers which have been directly observed are then derived from n=18 by various aneuploid changes and polyploidy. Some of the derivations are very complicated cytologically and it is perhaps more feasible to derive these numbers by straightforward polyploidy as suggested by Walker (20) from primitive base numbers of 7, 6 or 9, and 11. In both schemes the number 34 is derived from 18 by loss of a chromosome and subsequent doubling.

The derivation of *Selenodesmium* and *Macroglena* is particularly interesting since on morphological grounds Copeland (8) found it necessary to derive them independently from the majority of the trichomanoid genera (see diagram p.2). He also notes some resemblance between the cell walls, receptacle and involucre of *Selenodesmium* and *Meringium* although he believed their real affinity was remote. While such a resemblance may be the result of convergence it is perhaps also significant that the chromosome numbers of certain species attributed to *Selenodesmium* and *Meringium* fall into a numerical series based on 11 which could indicate some remote common ancestry. There is, therefore, some suggestion that the trichomanoid genera are not monophyletic and the origins of some of them are perhaps to be sought among the hymenophylloid groups; a feature permitted more readily by the scheme of chromosome evolution postulated by Walker than that put forward by Vessey & Barlow. Furthermore the trichomanoid and hymenophylloid groups are not always sharply differentiated morphologically and the cytology tends to endorse this view since the 36 chromosome series is widespread in both groups of species.

It is evident that Copeland's classification of the trichomanoid species is more natural than that of the hymenophylloid species. Many of his ideas on the relationships among the trichomanoid species have subsequently been supported by cytological findings although the morphological and cytological pattern among his trichomanoid genera leaves an impression of unnecessarily fine generic discrimination. On the other hand among the hymenophylloid species nearly all the genera are manifestly unnatural from the cytological point of view. While the morphology and chromosome number of certain genera suggest they should be merged with other genera (cf. *Myriodon*), taking the hymenophylloid species as a whole the various chromosome series perhaps indicates the number of genera might eventually be increased.

The understanding of the evolutionary relationships within the Hymenophyllaceae is still far from complete and on the basis of present knowledge it would be premature to make any firm taxonomic recommendations. Nevertheless Copeland's system of genera has often been criticised for its recognition of an excessive number of taxa and reducing their numbers would be desirable and convenient for identification purposes if this could be achieved without obscuring their relationships. The morphological and cytological pattern amongst the trichomanoid species in particular perhaps suggests a way by which the boundaries of a reduced number of taxa might be circumscribed.

The author wishes to express sincere gratitude to the Royal Society for the opportunity to visit the British Solomon Islands Protectorate and thanks Dr F. M. Jarrett, Royal Botanic Gardens, Kew, for her assistance in identifying the material.

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ON THE SIGNIFICANCE OF SOME NAME-CHANGES IN FERNS

R. E. HOLTTUM*

This article is written in response to the numerous complaints made by Reginald Kaye in his recent book, *Hardy Ferns*, about changes of names. But, like many others who make such complaints, he is not fully aware of the situation. As one who has made numerous name-changes, I would like to try to explain why I regard some such changes as necessary and significant, while, like Mr Kaye, I regard other changes as an unnecessary nuisance.

There are broadly two reasons why names are changed. One is that a better understanding of ferns has resulted in the realization that the definitions of genera made by the earlier taxonomists were very unsatisfactory. This has involved transferring specific names from one genus to another (e.g., *Polypodium dryopteris* L. becomes *Gymnocarpium dryopteris* (L.) Newm.).

The other reason is that, in an endeavour to ensure that each species has only one name, there is an international agreement that the earliest name is the correct one. But European plants have been named and described by so many authors, in so many books, that it is difficult to be sure that all such names and descriptions have been scrutinized; and sometimes new evidence on dates of publication makes changes necessary. The changes in recent years from *Dryopteris rigida* to *D. villarii*, and from *Thelypteris oreopteris* to *T. limbosperma*, are due to the discovery of earlier names for the species in question. It has been suggested that, when a name is well established and widely known (such as *T. oreopteris*) it should be possible for earlier names, if discovered, to be formally rejected, and this seems to me a sensible suggestion. But when put to the vote at International Botanical Congresses it has been defeated, on the grounds that the keeping of a list of rejected names is an intolerable nuisance, and that in the end the principle of priority will result in final and unchangeable names.

The history of the development of knowledge of ferns, which has led to better understanding of their natural classification, is long and complex, and the process of change of ideas is still incomplete. Recognized botanical classification begins with the publication of *Species Plantarum* by LINNAEUS in 1753. Linnaeus described a number of ferns, but his generic definitions were very unsatisfactory, and in the succeeding half century a great many more ferns were discovered and described.

Fifty years after Linnaeus, OLOF SWARTZ (also a Swede) published the first major work on the ferns of the world, *Synopsis Filicum* (1806). He distinguished those ferns which have sporangia of peculiar structure (such as *Ophioglossum* and *Osmunda*) and divided the rest into genera which were defined solely on the form and position of the sori and of their indusia.

Swartz's definitions of genera were later seen by other pteridologists to be unsatisfactory in various ways. The most obvious example of this was the definition of a genus *Polypodium*, which included all ferns with round superficial sori having no indusia; such ferns were extremely various in their vegetative form and in the arrangement of their veins. There were various attempts to use these other characters in new classifications, and to describe the sori more exactly. But W. J. HOOKER, who wrote the second great work on the world's ferns (*Species Filicum*, five volumes, 1844–1864) reverted to the artificial genera of Swartz; and Hooker's work was summarized in *Synopsis Filicum* (1867, second edition 1874) which remained the only work of its kind until the end of the century, when L. DIELS published a summary of the ferns in ENGLER & PRANTL's *Die Natürlichen Pflanzenfamilien*. Thus, though there were various different proposals for changes in generic concepts, Hooker's work was the one most generally in use, and his very comprehensive definition of *Polypodium* was adhered to by many authors, one result being that *Gymnocarpium robertianum* is still referred to as the Limestone Polypody, a name which has never been truly popular and which I think should be abandoned.

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One of the authors who attempted to devise better schemes of classification for ferns was JOHN SMITH of Kew (see Brit. Fern Gaz. vol. 9, pt. 8, 1967). He removed from *Polypodium* the terrestrial ferns with thick rootstock and tufted fronds (in habit like *Dryopteris filix-mas*) which lack indusia, realizing that they were very different in many ways from true *Polypodium*, which has a creeping rhizome with fronds separately jointed to it, and united them to the *Dryopteris* group of genera. It was clear to John Smith (and to other pteridologists of the 19th century) that the ferns we now call *Gymnocarpium dryopteris*, *G. robertianum*, and *Thelypteris phegopteris* were also allied to *Dryopteris* rather than to *Polypodium*, though they have slender rhizomes, so he removed them also from *Polypodium*. JOHN SMITH placed all these ferns in his Tribe *Phegopterideae* (in his *Historia Filicum*, 1875). But neither he nor anyone else in the 19th century saw clearly how to subdivide this great assemblage of terrestrial ferns, mainly tropical, into natural genera. The changes of the past century in *generic* names of our British ferns now included in the genera *Dryopteris*, *Polystichum*, *Thelypteris* and *Gymnocarpium* are due to varied efforts of different taxonomists to see a solution of this extremely complex problem.

Edward Newman was a British pteridologist who was mainly concerned with British ferns, not with the very much larger number of tropical species which had complicated the schemes of John Smith and others. Newman, like Smith, realized that our two species of *Gymnocarpium*, and also *Thelypteris phegopteris*, were wrongly placed in *Polypodium*, and in 1851 he proposed the new name *Gymnocarpium* for them, but few other authors followed him, and his generic name was almost forgotten until revived by Ching in 1933. In 1852 the French pteridologist A. L. A. Fée independently proposed a new genus *Phegopteris* to include these same species and a number of tropical ones which he believed to be allied to them, and Fée's name *Phegopteris* came into use by some other authors, including John Smith, who failed to notice the earlier publication of *Gymnocarpium*. The limits of *Phegopteris* were differently drawn by different authors.

At the beginning of the present century, CARL CHRISTENSEN (of Copenhagen) undertook to list all published names of ferns, and to indicate which names should be regarded as synonyms, in an *Index Filicum*, published 1905–06. In order to do this, he had to decide which generic names he would recognize, and how to define the genera. In general, he followed the arrangement of Diels, but he adopted the long-neglected generic name *Dryopteris* (Adanson 1763) for a large proportion of species included in *Aspidium* by Diels. His *Dryopteris* included the

British ferns we now call *Dryopteris*, and also *Thelypteris* and *Gymnocarpium*, with more than 700 other species. Christensen realized that this vast genus *Dryopteris* was a mixture of very diverse elements, and he immediately began to try to see a natural subdivision of it. To this end, he studied first the species of tropical America, examining especially their hairs, scales, and anatomy, with the result that he established for the first time a clear distinction between *Dryopteris* proper and *Thelypteris* (and also other groups, mainly tropical, now commonly regarded as separate genera). He then turned his attention to the species of Asia, and while he was so occupied R. C. Ching came to him from China, remaining three years in Europe. After his return to China, Ching began a long series of papers on the ferns of China and India; in these papers he applied to the flora of mainland Asia ideas gained from Christensen.

One of Ching's first papers (1933) dealt with the genus *Gymnocarpium*, which he believed had been wrongly united with *Thelypteris* by some authors. He revived Newman's forgotten generic name, and reinstated our two British species, but he excluded the species *phegopteris*, which he later placed in *Thelypteris*, in a monograph of that genus (re-defined by him) in Asia. There is now general recognition that *Gymnocarpium* is a natural genus, to which *Thelypteris phegopteris* does not belong (of modern authors, only Copeland has denied this). But unfortunately there has been a suggestion that the name *Gymnocarpium* is illegitimate and should be changed. I do not think that such a change is warranted, and am giving my reasons elsewhere.

In 1963 Ching published a further revision of *Thelypteris* in Asia, and divided it into several smaller genera. Among the latter is *Phegopteris*, construed in a narrower sense than that of Fée, and Ching included our Beech Fern in it as *Phegopteris polypodioides* Fée (the reduplicated name *Phegopteris phegopteris* is not permitted). Ching limited the genus *Thelypteris* to the Marsh Fern and two other species; and he restored *T. oreopteris* to a restricted genus *Lastrea*. The name *Lastrea* was first published by Bory in 1824 and was later used to comprise all the species we now call *Dryopteris* and many others; *Lastrea oreopteris* is the type species of *Lastrea*, which, as re-defined by Ching, comprises only a few species. I am doubtful whether his definition is a good one, and certainly it needs more study.*

The above is written to explain how new knowledge has shown that generic limits must be re-drawn to correspond better with natural relationships of the species. Such new knowledge is never complete, and certainly some of the genera of tropical ferns related to *Thelypteris* still lack clear definitions. I do not think that any further important change in the generic names of British ferns is likely on taxonomic grounds, except that it appears to me quite reasonable to regard our three British species of *Thelypteris* as representing three distinct genera (*Thelypteris*, *Lastrea* and *Phegopteris*) according to Ching's latest proposals; but I have no doubt that these three species are much more closely allied to each other than to any other group of ferns, and have no objection to their retention in a large genus *Thelypteris* by those who prefer to do so.

New evidence contributing to an understanding of natural relationships among ferns has been provided by cytological study, begun in this country by Professor

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* More recently, Holub has proposed the substitution of *Oreopteris* for *Lastrea*, as he considers the latter to be illegitimate.

I. Manton, and now world-wide in its scope. This has shown that well-established natural genera have constant basic chromosome numbers. The species of *Gymnocarpium* have the base number 40, and those of *Dryopteris* have 41. But the three species of *Thelypteris* have different numbers: *T. palustris* 35, *T. limbosperma* 34, and *T. phegopteris* 30. Thus cytological evidence supports the modern separation of *Gymnocarpium* from *Thelypteris*; and it would also support the disposition of our three species of *Thelypteris* in three distinct genera. The difficulty here is that the large number of tropical species have not yet been clearly assigned to such genera, which need to be defined with reference to other species besides the few in Britain.

Another case in which later study has shown that generic separation is warranted is that of *Asplenium* and *Athyrium*. Hooker and others united these two genera, with the mainly tropical *Diplazium*, as a comprehensive *Asplenium*; and even Christensen, as late as 1938, regarded these genera as so closely allied that he placed them in the same subfamily. It appears to me however that this is another of the many cases among ferns where similar soral forms have arisen on different evolutionary lines from different sources. The resemblance between *Asplenium* and *Athyrium* is that in both there are sori which run along the veins, with indusia covering them. But in *Athyrium* there are usually some sori which are *Dryopteris*-like in form, i.e., crossing the vein; such never occur in *Asplenium*. The shape of the vascular strand in the leaf-stalk, as seen in cross section, is different in the two genera, and also the structure of the scales. In recent years has come the evidence of cytology, which shows constantly a base number 36 for all species of *Asplenium* and 40 for *Athyrium*. Copeland has placed the two genera in different families, and in this I agree with him, though I do not agree with him in associating some other genera with *Athyrium* (which he places in a family *Aspidiaceae*).

Copeland has united *Diplazium* with *Athyrium*, so making the latter a very large genus; the two are certainly closely allied, but I believe that they should be kept separate. There are related smaller genera in Asia which have not yet been clearly defined, and these complicate the situation.

Mr Kaye complains about the substitution of the generic name *Phyllitis* for the *Scolopendrium* he knew in his younger days. But *Phyllitis* is by far the older name, having been used by many authors for two centuries before Linnaeus. Linnaeus altered former usage and named our Hart's-tongue Fern *Asplenium scolopendrium*. The first subsequent author to propose that it should be regarded as a genus distinct from *Asplenium* was Ludwig, who re-established the name *Phyllitis* in 1757. A few years later Adanson published *Scolopendrium* as a generic name for the same species, but neither Ludwig nor Adanson published a binomial for the full specific name. Sir J. E. Smith published the binomial *Scolopendrium vulgare* in 1793, and this name came into general use. It was the British pteridologist Newman who first published the combination *Phyllitis scolopendrium* in 1844; but he cited the pre-Linnean John Ray as his authority, for which reason his name was ignored. It was not until after 1900 that Ludwig's publication was re-discovered, and Newman's action justified; his name appears in Christensen's *Index Filicum* of 1905.

Finally I will consider the case of the Ostrich Fern, correctly known as *Matteuccia struthiopteris*. Linnaeus gave it the name *Osmunda struthiopteris*, and included with it in *Osmunda* several other ferns which we now consider generically distinct, one of these being *Osmunda spicant*, which we now know as *Blechnum* *spicant*. In 1770 F. G. Weis, in a work on the ferns of Göttingen, proposed a new genus *Struthiopteris* for *O. spicant* Linn., and published the binomial *Struthiopteris spicant*. This was the first use of *Struthiopteris* as a generic name. About 1800 Bernhardi made the first considerable attempt to clarify some of Linnaeus's fern-genera, and, in subdividing *Osmunda* Linn., he restricted that generic name to the species we now know as *Botrychium*, removing *Osmunda regalis* to a separate genus which he called *Struthiopteris* (failing to notice the earlier usage of Weis). In 1809 Willdenow, regarding the name *Struthiopteris* as properly applicable only to the Ostrich Fern, published the name *Struthiopteris germanica*, thus using the generic name in a third different way. The confusion was finally resolved in 1866 by Todaro, in a work on the ferns of Sicily; he proposed the name *Matteuccia* to replace *Struthiopteris* Willd. non Weis nec Bernh. But Willdenow's name *S. germanica* continued to be widely known and used, and was evidently familiar to Mr Kaye before he came to write his book. The result is that he has inadvertently coined the new name *Matteuccia germanica*, and so has after all become himself a name-changer. Fortunately, this new name is not validly published, as its citation fails to meet the requirements of the present International Code.

REVIEWS

DIE FARNPFLANZEN ZENTRALEUROPAS, Gestalt, Geschichte, Lebensraum, by K. & H. Rasbach (photographs) and O. Wilmanns (text), 296 pages, 146 illustrations (mostly black-and-white half-tone photographs). 24½ × 31½ × 2 cms. Quelle & Meyer, Heidelberg 1968. Price 38DM; about £4.

This handsomely produced, nicely bound quarto-sized volume contains 146, for the most part full page, photographs of ferns, horsetails and clubmosses. Without exception each is an exhibition picture taken by skilled photographers who obviously knew something about the plants they were portraying. The authors state in the Foreword that their first motive for the book was 'the joy in its [nature's] beautiful, noteworthy and manifold forms', and indeed their pictures have something for each of the amateur, teacher and specialist investigator alike. Not only are fern portraits taken but also the pictures show associations and habitats. And without reading one word of the text other than the names of the 77 species illustrated (out of a possible 90 Central European species) the book can be enjoyed, used and proudly owned.

There is of course much more to the book than that. Professor Doctor Ottilie Wilmanns has written a full and well organised text, covering Central Europe in the *Flora Europaea* sense, i.e. Ge, Po, He, Au—Germany, Alsace-Lorraine, Poland, Switzerland and Austria (in fact the Alps from the southern slopes of Mont Blanc to N Jugoslavia and the Carpathians); the nomenclature also follows *Flora Europaea*. In the general introduction (pages 9–84) ferns are thoroughly dealt with from all aspects—development (no mention of apogamy, though), physiology, prothallus, anatomy, evolution (telome theory and gene pools, with a natural emphasis on D. E. Meyer's work on *Asplenium* in Central Europe), general classification, plant geography and palaeontology (here are some odd things mentioned, e.g. Silurian of Australia but no mention of British or other good European deposits).

The main body of the book is that part where each species is discussed in full but the species are grouped under eleven habitats: rock faces and ledges; screes;

(*Cont. on page 105*)

IDENTIFICATION OF A DIPLOID ANCESTRAL GENOME IN THE *DRYOPTERIS SPINULOSA* COMPLEX

S. WALKER*

Early cytogenetic work on the *D. spinulosa* complex (WALKER, S. 1955) indicated that the three species *D. cristata* (L.) Gray, *D. spinulosa* (O. F. Muell.) Watt (now regarded as *D. carthusiana* (Vill.) Fuchs) and *D. dilatata* (Hoffm.) Gray are allotetraploids requiring four ancestral genomes to account for their origin. If these genomes are represented by the letters A, B, C and D, then the constitution of the three tetraploid species may be regarded as AABB (*D. cristata*), BBCC (*D. spinulosa*) and CCDD (*D. dilatata*). The genome B is common to the two former species and genome C to the two latter. Genome C has been shown (WALKER, S. 1955, 1961) to be now represented by the diploids *D. assimilis* S. Walker, *D. maderensis* Alston, "*D. dilatata*" in Western North America and *D. intermedia* (Muhl.) Gray in Eastern North America. No other ancestral genomes were known to be represented by living species at that time.

In recent years synthetic hybridization of North American species has shown that *D. ludoviciana* (Kunze) Small, is a diploid which represents one of the ancestral genomes in *D. cristata*. *D. ludoviciana* has a relatively restricted distribution, frequenting low or wet hammocks, cypress swamps or rocky woods in the Coastal Plain, Florida to Louisiana and North Carolina. It has a creeping rootstock and the shape of its frond is not unlike that of *D. cristata*. When sterile *D. ludoviciana* has been confused with *D. cristata*, but when fertile the fronds of the two species are quite distinct (Figs 1 and 3), that of *D. ludoviciana* exhibiting dimorphism due to the abrupt difference of the spore-bearing pinnae from the sterile ones below them.

I have not seen any specimens of wild hybrids between the two species, though the geographical ranges of *D. cristata*, a more northern species, and *D. ludoviciana* do meet in North Carolina. I have however been able to synthesize hybrids using either species as the female parent. The outline of a fertile frond from a hybrid, with *D. cristata* as the female parent, is shown in Fig. 2. The dimorphism of the frond is not so marked but is present. Meiosis is irregular and spores abortive. *D. cristata* is tetraploid with n=82 and *D. ludoviciana* is diploid with n=41. The hybrid is triploid and analysis of first meiotic metaphase shows 36 or 37 bivalents together with correspondingly 51 or 49 univalents.

As *D. cristata* is an allopolyploid the degree of chromosome pairing in the synthesized hybrids indicates genomic relationship and *D. ludoviciana* may be regarded as part parental to *D. cristata*. It is of interest that J. K. SMALL in 1938 (p. 267) wrote:

"Did *Dryopteris cristata* and *D. ludoviciana* have a common ancestor? Or is one an offshoot of the other?"

In 1962 I gave evidence from work on North American ferns, that *D. celsa* (Palmer) Knowlton, Palmer and Pollard is an allotetraploid derived from the diploids *D. ludoviciana* and *D. goldiana* (Hooker) Gray. Hence a hybrid between

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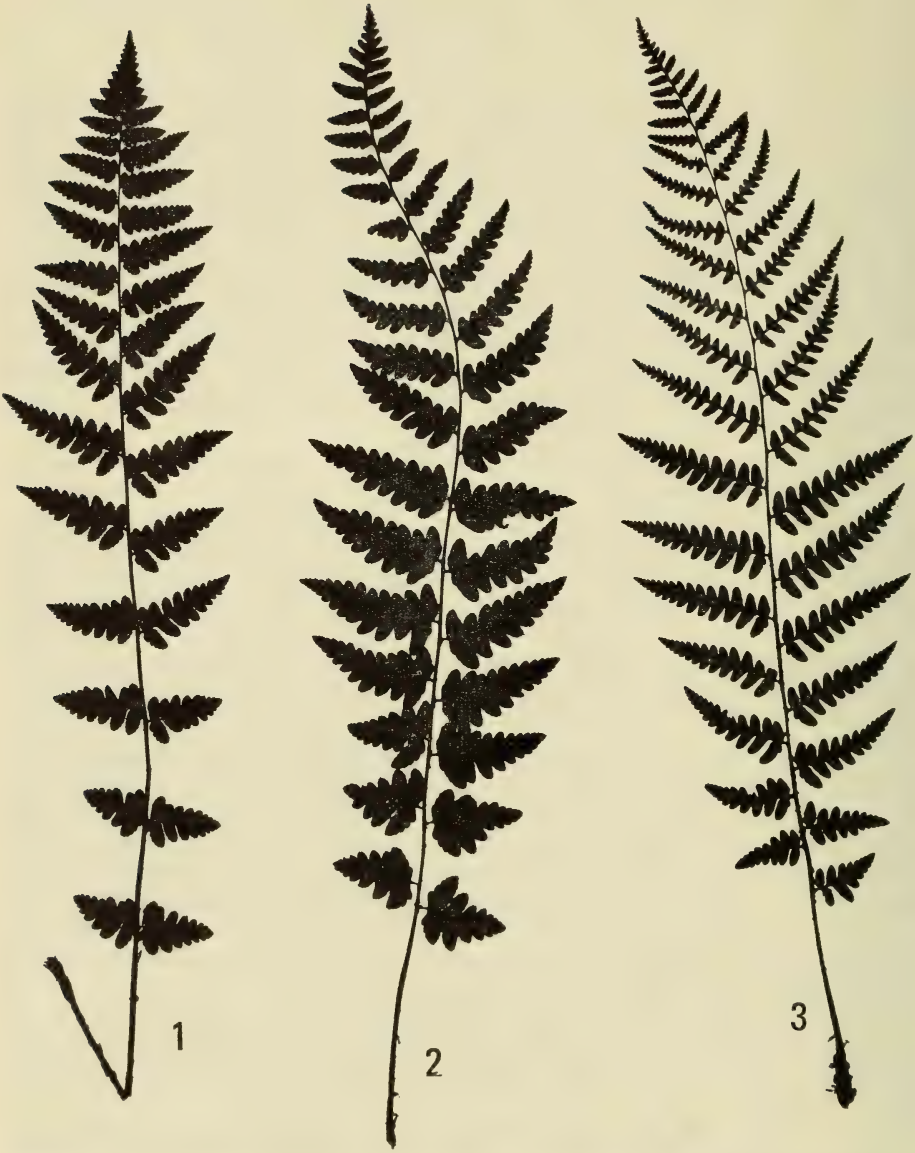

FIGURES 1–3. Fertile frond silhouettes. **1** *D. cristata*; **2** the synthesized hybrid *D. cristata* × *D. ludoviciana*; **3** *D. ludoviciana*.

D. cristata and *D. celsa* may be expected to exhibit approximately n bivalents and 2n univalents during meiosis since the genome of *D. ludoviciana* is common to both. This has been found to be the case by investigations on wild hybrids by WAGNER, W. H. and WAGNER, F. S. (1965). It still remains uncertain whether *D. ludoviciana* represents genome A or B in the *D. spinulosa* complex. If it is B, then *D. ludoviciana* should show a high degree of chromosome pairing with *D. spinulosa*. As yet no wild or synthesized hybrids between *D. ludoviciana* and *D. spinulosa* are known. However, if WAGNER and WAGNER (1965) are correct in their identification of wild hybrids between *D. celsa* and *D. spinulosa*, then their finding of very few chromosome pairs in this hybrid would suggest that *D. ludoviciana* (part parental to *D. celsa*) is not related to *D. spinulosa*. This would suggest *D. ludoviciana* represents genome A in the *D. spinulosa* complex.

SUMMARY

Synthesized hybrids between allotetraploid *D. cristata* and diploid *D. ludoviciana* show that *D. ludoviciana* represents one of the ancestral genomes present in *D. cristata*.

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THE BPS EXCURSION 1968 TO DALMALLY

J. W. DYCE

It is not often we go north of the Border for our Annual Excursion, and it seemed that with the reversal in the usual weather conditions existing this year we would be sure of a dry week. A disappointingly small party of our members spent the previous week on the Isle of Arran, when we did enjoy some of that sunshine which scorched the Western Highlands, creating drought conditions unprecedented in living memory. However, there was no need for worry after we arrived at Dalmally, and we "enjoyed" our usual mixture of plenty of rain with a little sun!

We foregathered* on Saturday 31st August at our centre, the Carraig-Thura Hotel in the village of Lochawe near Dalmally. The hotel stands on high ground overlooking the headwaters of Lochawe, with the ancient ruined Kilchurn Castle below on an isthmus jutting into the Loch and high mountains all round. Behind towers Ben Cruachan and to the east over the Loch can be seen Beinn Laoigh (Ben Lui) and other high peaks.

We started with an easy day on the Sunday, exploring along the road down the eastern side of Loch Awe. Woodland extends along the shore with gentle slopes leading up to the open hillside, and our first stop was to the south of Sonachan to look over this terrain but we found only a small number of the common large-growing ferns, in addition to some *Polypodium vulgare* and *Asplenium trichomanes* on the walls of a ruined cottage. The next halt was at the Allt Beochlich where the stream cascades down the hill to the Loch in a series of waterfalls in a deep narrow corrie, most of which was inaccessible. Here ferns were abundant, and 14 species were found during a short scramble, penetrating into the corrie wherever possible. *Athyrium filix-femina*, *Dryopteris borreri*, *D. dilatata*, *Thelypteris limbosperma* and of course *Pteridium aquilinum* were common, also *Blechnum spicant*, with *Gymnocarpium dryopteris* and *T. phegopteris* draping some of the steeper slopes. *A. trichomanes*, *A. viride*, *Cystopteris fragilis* and *P. vulgare* were also there, and we noted some fine large plants of *Polystichum aculeatum* seemingly happy in the very humid conditions close to one of the waterfalls. On the wet rocks *Hymenophyllum wilsonii* was rambling vigorously and one fern ally was seen, *Selaginella selaginoides*. Later in the week a few members returned to the spot to explore it more thoroughly, but found no additions to the species already noted. Some miles further south we stopped again at Eredine with Forestry Commission woods stretching along the Loch in both directions. It now began to rain and soon was coming down hard, putting a stop to our activities for the day. Before conditions became too bad, a short walk along the roadside in this very sheltered spot with lush vegetation enabled us to record 12 species including *A. trichomanes*, *C. fragilis*, *P. aculeatum* and two Polypodies, *P. interjectum* and *P. vulgare*.

The rain continued all evening and most of next day, following us as far afield as Loch Tay where our objective was Lochan na Lairige, a small loch high in the hills between Ben Lawers and Meall nan Tarmachan. The Lochan together with many more of the high-level lochs in the Highlands, is part of that vast hydro-electric power undertaking which covers a great part of Scotland, and thanks to this the road, rising steeply from Loch Tay, is a good one up to and for a short distance beyond it, thereafter reverting to its original state of a rough mountain track leading over into Glen Lyon. From the head of the Lochan we scrambled round to some cliffs on the far side where the rare *Woodsia alpina* grows. After some searching the fern was found, a few plants growing in cracks on the face of the cliff, and near by *P. lonchitis* was a frequent inhabitant of sheltered corners. *W. ilvensis* is also recorded from here, but we sought it in vain. Other ferns on the rocks were *A. trichomanes* and *A. viride*, also *C. fragilis* very dwarfed and looking superficially so like the Woodsia that it was a trap for the unwary. In the boulder screes below the cliffs *T. phegopteris* was well established and the bigger crevices gave shelter to many of the larger ferns, including *D. abbreviata*. Higher up *D. assimilis* was seen, along with *Lycopodium alpinum*, *L. selago* and *S. selaginoides*. In damp flushes lower down grew two Horsetails, *Equisetum palustre* and *E. sylvaticum*. In all 14 ferns and 5 allies were found near Lochan na Lairige.

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*H. J. Bruty, H. V. Corley, Dr J. Davidson, G. Gilbert, Mrs C. E. U. Holttum, Prof. R. E. Holttum, Dr F. M. Jarrett, Mrs M. Kaye, R. Kaye, Mrs B. J. Tingey, F. J. Tingey, A. J. Worland, M. R. Worland, W. Wright, M. J. Young and the Secretary.

Driving rain sweeping across the hills did not encourage enthusiastic hunting, and after lunch taken in the shelter of the cars we retreated to lower ground and explored up Glen Lochay which runs deep into the Breadalbane mountains from Killin. The Glen is well wooded at the lower end and where it narrows at the Falls of Lochay the shade and humidity conditions make it an ideal habitat for a large fern population, from the tall woodland species to the small *H. wilsonii* growing exceptionally well in extensive colonies. Those graceful ferns, *G. dryopteris* and *T. phegopteris* were in abundance clothing the banks with their delicate fronds, and we also noted that elusive fern, *D. carthusiana*, our one and only record for this species during the whole week.

On Tuesday, again in rain, we travelled down Loch Awe and across to the west coast on the shores of the sea-loch Loch Craignish. From Kilmartin, Hugh Corley's Landrover was the only conveyance capable of negotiating the rough track, and we were transported, well shaken up, to the high ground above the Forestry Commission woods at Ormaig, to gaze westwards on a wondrous scene which had opened before us. Below lay the Loch dotted with islands, large and small, all with lovely sounding Gaelic names, Eilean Righ, Eilean Dubh, Eilean Mhic Chrion, Eilean na Highinn and many others. Beyond lay the Craignish peninsula, and on a clear day from the higher ground the view opens out over the Firth of Lorn to Mull, with the islands of Shuna, Luing, Lunga, and literally hundreds of smaller ones lying between. Standing at gaze, one is reluctant even to think of ferns, and even more reluctant to turn from such a restful landscape back to the scurry and turmoil of the everyday world.

Although the rain had stopped, all the vegetation, most of it tall-growing *Pteridium aquilinum*, was dripping wet and the midges, the "Curse of the Highlands", were biting viciously, so there was no incentive to stray from the path leading downwards parallel to the shore through the trees. Ferns grew in profusion, and in more congenial conditions we could have had a busy and interesting day exploring the wooded hillside, on which Hugh Corley in the past has found possible hybrids of *Dryopteris aemula* crossed with *D. dilatata* and *D. assimilis*. All these species abounded by the side of the path and there was plenty to occupy our attention without straying further afield. In addition we found *A. filix-femina*, *Blechnum spicant*, *D. borreri*, *T. limbosperma*, *T. phegopteris*, *P. vulgare* and *H. wilsonii*. At the deserted Ormaig farmhouse a few others were noted on the walls, *Asplenium adiantum-nigrum*, *A. ruta-muraria*, *A. trichomanes*, and of particular interest, *Ceterach officinarum*, by no means a common fern in this part of the country and nearing the northern limits of its range.

On Wednesday there was a division of interest, some of the party deciding to forget ferns for a day and go sight-seeing, and others to spend an easy day revisiting some interesting places near at hand. We divided after a visit to Kilchurn Castle, a medieval stronghold of Clan Campbell built in 1440 by the Breadalbane branch of the Clan and occupied by them until the middle of the eighteenth century. The old walls seemed a suitable abode for many ferns and we were surprised to find that only three species occupied them in scant numbers, *A. ruta-muraria*, *A. trichomanes* and *P. interjectum*. The discovery of the water fern, *Pilularia globulifera* in the loch below the castle, accompanied by *Equisetum fluviatile* was some consolation.

Ben Cruachan slopes steeply up from the northern shore of Loch Awe, and a scenic road runs by the water's edge and through the Pass of Brander. High up on the mountainside is the Cruachan Reservoir, another of the hydro-electric power high-level dams, and its overflow waters pour down the mountain in a deep corrie to the Falls of Cruachan which were our first objective after leaving Kilchurn Castle. The corrie was not accessible however, and we had to content ourselves with a climb up the mountainside above it with occasional downward glimpses at its rock walls festooned with ferns, most of them too distant for positive identification except for the more distinctive species, like *T. phegopteris* which could be seen curtaining some of the less abrupt descents. Where the corrie descends to the road we were able to penetrate its gloom for a few yards, and to note *A. adiantum-nigrum*, *A. trichomanes*, *P. interjectum* and *H. wilsonii* growing on the rock walls, while the larger ferns, *A. filix-femina*, *B. spicant*, *D. borreri*, *D. dilatata* and *D. filix-mas* flourished wherever they could find a footing. On the open hillside *P. aquilinum* and *T. limbosperma* were common, but more species than the 12 we saw must exist in that corrie. Below the Falls the shore line of Loch Awe widens sufficiently for offices and other buildings of the Hydro-Electric Board to find flat foundations, but apart from a tunnel entrance there is nothing to indicate that in addition to these external buildings, there is, deep inside the rock of Ben Cruachan a huge underground power station, the second largest in the world, which was completed in 1965.

After passing through the Pass of Brander a short stop was made at Bridge of Awe to have a look at the old bridge which has been by-passed a little distance away by a modern one carrying the new road. We found it well covered with extensive colonies of *A. ruta-muraria* and *A. trichomanes*, and obviously an ideal habitat for these ferns. At Taynuilt we took the road south through Glen Nant, a narrow valley with steep rocky wooded slopes and a rushing river above which the road has been cut into the hillside. It is a perfect place to foster the luxuriant growth of ferns in variety and great profusion. We found 14 species in this lovely spot and only one was not present in large numbers—*Polystichum aculeatum*, of which only a few plants were found. The common woodland ferns flourished, while *G. dryopteris* and *T. phegopteris* spread vigorously everywhere and *H. wilsonii* was plentiful on all the wet rocks. We were particularly interested in the abundance of *D. assimilis*, growing to a large size, which gave some of us, still not too familiar with the characters which have removed this fern from the *carthusiana/dilatata* complex and given it specific rank, the opportunity to study it closely.

A dry day on Wednesday led us to hope that the weather was on the mend, and we were encouraged the following morning by brilliant sunshine as we commenced the climb of Beinn Laoigh (Ben Lui), a mountain rich in alpine flora and many rare plants. Our purpose was to explore the cliffs on the north side of the mountain for the rare *Cystopteris montana*, and this entailed a long climb from the road in Glen Lochy. Only a few of our more energetic members completed the climb, to be rewarded by the sight of a wonderful rock garden, with all manner of alpine plants, some in secondary bloom, festooning the cliffs and creeping over the screes or through the grass, many of them forming large cushions. The time to visit this place is undoubtedly the Spring when the cliffs and the whole mountainside must be a wonderful mass of colour.

The promise of the morning was not fulfilled for during the climb the weather deteriorated, a bitter penetrating wind rose and then the rain started, a driving cold rain that soaked and chilled us, and took the edge off our zest for fern hunting. Nevertheless we resisted the temptation to retreat, and continued our search along the cliffs but we did not find *C. montana*, although many other ferns were seen, among them *Woodsia alpina* and *P. lonchitis*, the latter along with *A. viride* and *C. fragilis* very common at high altitudes. *A. filix-femina. D. abbreviata* and *D. dilatata* were frequent, and with them in the screes on the high slopes were dwarf forms of *D. assimilis*, one in particular being very attractively divided. Only at low levels did we find *D. borreri*, but *B. spicant*, *T. limbosperma*, and the fern ally, *Selaginella selaginoides* were common all the way up the mountain. We were pleased to find a couple of plants of *Cryptogramma crispa* in a scree near the cliffs, and there was also some *H. wilsonii* on shaded rocks high up. Quite at home in high places, *G. dryopteris* and *T. phegopteris* rambled happily on the screes and in the rock crevices, and the Clubmosses, *Lycopodium alpinum* on the grass slopes and *L. selago* on the rocks, were frequent. A long wet trudge took us back to the road and the shelter of the cars, and we were glad to return to the warmth of the hotel.

The favourable report of those who visited Glen Nant on the Wednesday decided the whole party to return there on Friday the last day of the Excursion, and soon we were scattered along the river and on the hillsides but added nothing new to the records made two days earlier. Later in the morning an unfortunate accident befell Dr Jarrett which necessitated us taking her to hospital in Oban where she had to remain for several days before she was able to return home, fortunately none the worse after an unpleasant experience. The incident cast a gloom over the party, very little more hunting was done, and we returned early to the hotel to attend to many arrangements made necessary by the accident, and to prepare for our departure on the following morning. We were very grateful to Mrs Short, the proprietrix of our hotel, who did everything possible to help in the emergency and we have to express our appreciation and thanks for her practical sympathy.

In the following list of ferns seen during the Excursion, figures 1–17 (**bold** = new record, * = confirmation of pre-1930 record, for the *Atlas of the British Flora*) refer to localities:

Asplenium adiantum-nigrum—5, 10, 14, 15
A. ruta-muraria—5, 6, 13, 15
A. trichomanes—1, 3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15, 17
A. viride—3, 4, 7
Athyrium filix-femina—1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17
Blechnum spicant—1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 16, 17
Ceterach officinarum—**15**

Cryptogramma crispa—7
Cystopteris fragilis—1, 3, 4, 7, 9, 14
Dryopteris abbreviata—**3, 7**
D. aemula—**16**
D. assimilis—**3, 7, 11, 16**
D. borreri—1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17
D. carthusiana—**1**
D. dilatata—1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 16, 17
D. filix-mas—1, 2, 3, 8, 9, 10, 11, 14, 17
Equisetum fluviatile—13
E. palustre—3
E. sylvaticum—3
Gymnocarpium dryopteris—1, 4, 7, 11
Hymenophyllum wilsonii—1, 2, 4, 7, 10, 11, 16
Lycopodium alpinum—3, 7
L. selago—3, 7, 11
Pilularia globulifera—**13**
Polypodium interjectum—6, 9, 10, 13, 14
P. vulgare *sensu stricto*—4, 8, 9, 11, 14, 15, 16, 17
Polystichum aculeatum—4, 9, 11
P. lonchitis—3, 7
Pteridium aquilinum—1, 2, 4, 5, 6, 8, 9, 10, 11, 12, 15, 16, 17
Selaginella selaginoides—3, 4, 7
Thelypteris limbosperma—1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 15, 16, 17
T. phegopteris—1, 3, 4, 6, 7, 9, 10, 11, 12, 16
Woodsia alpina—3, 7

	V.C. 88 Mid Perth (*O.S.* 1 *in. map ser.* 7 *sheets* 47, 48)	Date visited September	National Grid ref.
1	Falls of Lochay	2	27/5335
2	Glen Lochay near Batournie	2	5036
3	Lochan na Lairige	2	5940
	V.C. 98 Main Argyll (*O.S.* 1 *in. map ser.* 7 *sheets* 46, 52, 53)		
4	Allt Beochlich	1	0015, 0115
5	Ardgenavon	5	1611
6	Bridge of Awe	4	0229, 0329
7	Ciochan Beinn Laoigh	5	2627
8	Dalmally, junction of roads A85 and A819	1	1427
9	Eredine	1	17/9609
10	Falls of Cruachan	4	27/0726, 0727, 0826, 0827
11	Glen Nant	4, 6	0127, 0128
12	Inveraray, 1½ miles north of	5	0810
13	Kilchurn Castle	4	1327
14	Kilmartin	3	16/8398, 8399
15	Ormaig Farm	3	17/8202, 8203
16	Ormaig Woods	3	8101, 8102
17	Sonachan House, 1 mile south of	1	27/0219, 0319

REVIEWS (cont. from page 96)

stream sides; anthropogenic grassland; acid grassland; dwarf shrub heath; hochmoor (bog); scrub; conifer woods; deciduous alder (wet) and mixed beech (dry) woods; and standing water. Plant associations are discussed, as are geographical ecological sites like the Steiermark Serpentines. This arrangement increases the use of the book enormously. The emphasis throughout is on the ecology of the species and its reason for being where it is usually found, and on the whole the text is orientated to the layman.

This book is excellent value; all university libraries should have a copy, and any botanist or general naturalist interested in the flora of Europe will want to buy it without hesitation.

A. C. JERMY & JUDY SKOG

WELSH FERNS, Clubmosses, Quillworts and Horsetails, a descriptive handbook by H. A. Hyde and A. E. Wade, Fifth Edition, revised, expanded and rearranged by S. G. Harrison, 178 pages, illustrated in black-and-white with 14 plates and 85 text-figures. 15 × 22½ × 2 cms. National Museum of Wales, Cardiff, February 1969. Price 25s.

Welsh Ferns has long been regarded as the British pteridologist's 'Bible'. This latest edition with, for the first time, clubmosses, quillworts and horsetails in the same detail as the ferns, is even more so and is surely the one we have been waiting for. Seven years have elapsed since Edition 4 and certainly much more is known about the distribution of ferns in Wales since then; only one new species (*Dryopteris assimilis* S. Walker) and two new hybrids (*Asplenium adiantum-nigrum* × *septentrionale* and *Dryopteris abbreviata* × *filix-mas*) are new to the Welsh flora. Although intended for Wales it should be pointed out that this book deals with all British ferns etc., and this edition even more fully than before.

It has been thoroughly revised by S. G. Harrison and he alone is responsible for the text of the fern allies, although the drawings of these plants were prepared for a much earlier edition when lack of finance prevented their inclusion. In several cases Mr Harrison has re-written and improved (by keys where recent research has clarified a complex, e.g. *Polypodium*; or from his own field experience of the group, e.g. *Dryopteris*). The arrangement of families is based on that of Professor R. E. G. Pichi-Sermolli after discussion with many pteridologists. I think this is more logical and the user of the book will not find the change inconvenient.

Taxomically the book is little changed and follows *Flora Europaea* (1964) mostly, except for *Asplenium adiantum-nigrum* subsp. *onopteris* which in *Flora Europaea* is treated at specific rank, and *Lycopodium* here as one genus instead of four. This deviation is justified, but so would have been the placing of *Polystichum falcatum* (the Japanese Holly Fern) under the more acceptable genus *Cyrtomium*. I think there is good evidence, however, for accepting each of the three *Thelypteris* species (*T. palustris*, *T. phegopteris* and *T. limbosperma*) in different genera, *T. palustris* alone remaining in *Thelypteris*.

Fée raised *Phegopteris* to generic rank well over a century ago; the correct name for our species is *Phegopteris connectilis* (Michx) Löve & Löve. J. Holub (in Folia geobot. phytotax., Praha **4**:33–53, 1969) has described a new genus *Oreopteris* to include *T. limbosperma* (the correct name being *O. limbosperma* (All.) Holub). On the other hand there is ample evidence (see Lovis & Vida, this Journal p. 63) for regarding *Ceterach* and *Phyllitis* all within *Asplenium*.

There are changes of nomenclature which the average botanist will accept grudgingly. *Isoetes setacea* Lam. for *I. echinospora* Durieu is an unfortunate change for which I am partly responsible. When I wrote the account of *Isoetes* for *Flora Europaea*, I was aware than Rothmaler and later Fuchs had identified the type-specimen of *I. setacea* Lam. as *I. echinospora.* I had seen only a photograph and been told that the plants were immature, and I had agreed that, superficially, this specimen did indeed have the habit of *I. echinospora.* However, I have since had occasion to study this specimen in the Paris Museum and through the kindness of Mme Tardieu-Blot I was able to remove a few immature megaspores and study them under the scanning electron microscope. Only now, after seeing some hundreds of megaspores from a wide range of species and at various stages of maturity, do I feel confident in placing the Lamarck specimen in the section Tuberculatae and not Echinatae. In other words we must revert to the *status quo* and I must apologise profoundly to Mr Harrison and others who have taken up the name *I. setacea* Lam., the identity of which is now being investigated.

Dryopteris carthusiana (Vill.) H. P. Fuchs has been accepted since C.T.W. ed. 2 (1962); it is by no means certain, however, that Villars' plant was the species we used to call *D. spinulosa* Watt, and further investigation is needed. I was recently stimulated into looking into the typification of *Dryopteris austriaca* (Jacq.) Woynar by C. V. Morton of the U.S. National Herbarium. No holo- or iso-type of *Polypodium austriacum* has been found, either at Vienna in Jacquin's Herbarium or elsewhere, but a Jacquin Herbarium specimen 'montis Hungaricis' in the BM fits his original description well (except for size) and has therefore been designated lectotype. Jacquin gives the measurements of typical *D. dilatata*, but it would have been natural for him to collect smaller specimens for distribution to his correspondents. I agree with Morton in identifying *Polypodium austriacum* Jacq. as *D. dilatata* and in doing so must accept *D. austriaca* (Jacq.) Woynar as the earlier and legitimate name. *Athyrium alpestre* is another name that must go, solely on the grounds that *Polypodium alpestre* of Clairville, the type of which is at Zürich and I have seen, is without doubt *A. filix-femina* (L.) Roth. One change, for the well-known British fern *Dryopteris borreri*, will be known to most; the reason is that Newman, in his preamble to the description of the segregates of the *D.* (as *Lastrea*) *filix-mas* complex (Hist. Brit. Ferns p. 186, 1854) clearly states that he does not regard them as species but as varieties and his name was strictly *L. filix-mas* var. *borreri.* Nobody had elevated this to specific rank before Wollaston described *Lastrea pseudo-mas*, and this species epithet must therefore be used as *D. pseudo-mas* (Woll.) Holub & Pouzar in Holub, Folia geobot. phytotax., Praha, **2:** 332 (1967).

Common English names have been well considered and should be used as a standard. There are some gaps which could have been filled however: Dickie's bladder-fern, alpine buckler-fern, intermediate polypody.

Harrison was, of course, bounded by the lay-out and typography of the earlier editions. It is difficult to see how it could have been bettered to any great extent; the publishers are to be congratulated in choosing the typography that withstood the test of time. There are always difficulties when so many hierarchial headings are required. Many of these are not needed in the text in fact, if there is a good synopsis at the beginning of the book (as here).

Anyone interested in ferns, field botany or the Welsh flora will automatically get this book. I strongly recommend it to students as a useful adjunct to the Pteridophyta course; it will be 25/- well spent. It is a general reference book on distribution, classification, biology and morphology of the British pteridophyte genera and species and I hope there will be few schools or public libraries without it.

A. C. JERMY

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Printed by the Devonshire Press, Torquay, England

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THE BRITISH FERN GAZETTE

VOLUME TEN PART THREE

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The papers in this number include the remainder of those submitted for volume ten part two which was dedicated to Professor Irene Manton, f.r.s. upon her retirement from the Chair of Botany at Leeds University

THE BRITISH FERN GAZETTE Volume 10 Part 2
was published on 19 August 1969

THE CONING BEHAVIOUR OF THE GENUS *EQUISETUM* IN BRITAIN

J. G. DUCKETT*

INTRODUCTION AND OBSERVATIONS

Although much has been written on the taxonomy of the genus *Equisetum*, (HAUKE 1963, MILDE 1867, MARIE-VICTORIN 1927) little has been published on the coning behaviour (MANTON 1950) and the physiology of the phenomenon is not understood (HAUKE 1966). Examination of large numbers of fertile herbarium specimens of British Equiseta indicates that the information given by CLAPHAM, TUTIN & WARBURG (1962) about the months when spores are shed may not be correct. In this paper are presented observations on the phenology of all nine British species of *Equisetum*, both from wild populations and from material grown in pot culture in the Botanic Gardens Cambridge, over the period 1965–1968.

Those species which bear their cones, either on separate colourless shoots (*E. arvense*, *E. telmateia*), or on special colourless apical portions of green shoots (*E. sylvaticum*, *E. pratense*), will be considered first. In all these species, which shed their spores in spring, the cone primordia develop during the preceding summer and meiosis occurs in September (MANTON 1950). The spores develop through the autumn in cones at, or just below the soil surface, until by October they have almost attained their full dimensions and the formation of the complex wall is complete. They differ from mature spores only in their lack of chlorophyll, slightly smaller dimensions and inability to germinate. The final maturation of the spores, whereby they become rich in chlorophyll and bright green in colour, occurs in the early spring as the fertile shoots begin to elongate.

The commonest and most widespread horsetail in both the British Isles and the world is *E. arvense* and this species appears to produce cones with equal readiness all over the British Isles (TABLE 1). Here, in any one stand, a succession of fertile shoots grows up over a period of 4–8 weeks, and the spores are shed very rapidly from each cone. At a particular site the number of cones may fluctuate very widely from year to year and some British populations are persistently sterile while others are invariably fertile. Similar phenomena have been observed in North America (HAUKE 1966) and possible explanations are discussed below.

In Britain, the spores of *E. telmateia* tend to be shed over a 6–8 weeks period commencing 2–3 weeks earlier than that of *E. arvense* in the same area. In any one area some stands likewise are fertile year after year and others sterile in spite of being vigorous and well established. The number of cones produced by different fertile stands varies considerably and this is perhaps related to geographical distribution. In the north of England far fewer cones appear to be produced than further south.

In *E. sylvaticum*, on the other hand, the expansion of fertile shoots is limited to 2–3 weeks at the end of April and beginning of May.

Although fertile British specimens of *E. pratense* are frequent in herbaria, and MANTON (1950) states that a colony of this species in the grounds of a school in Gloucester produces cones annually, I have seen neither cones nor cone buds in any of the localities listed in Table 1 in the last four years. One must, therefore, conclude that coning of this species in Britain is somewhat infrequent.

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*Department of Botany, University College London.

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E. pratense has a very restricted, disjunct, arctic-alpine distribution in Britain and even where it occurs is probably surviving under far from optimal conditions. The sporadic coning is perhaps related to this.

In species of *Equisetum* with deciduous, green aerial shoots on which cones are also borne (*E. fluviatile*, *E. palustre*) meiosis occurs in the young sporangia on the newly emerging green stems and only very immature cones may be found in the resting buds of the previous autumn (MANTON 1950). The spores develop and mature rapidly on the emerging stems and are almost always shed immediately after they reach maturity.

Spore liberation in *E. fluviatile* usually occurs from mid-May until the end of June, but occasionally a few fertile shoots are produced throughout the summer whose spores are liberated well into September. In a colony at Whalley, Lancashire, cones were produced in the late summer of 1965 and the spores matured in September. These were however not liberated until the following April, the fertile shoots remaining green through the winter.

TABLE 1

Coning behaviour of different populations of *Equisttum* subgen. *Equisetum* in Britain 1965–68

Species	**Locality**	**Grid reference**	**Habitat**	**Months when spores were shed**	
				acc. C.T.W. 1962	obs. J.G.D. 1965–68
Section Vernalia					
arvense	Coverack, Cornwall	10/786190	flushed stream bank	4	3–4
	Upper Teesdale	35/850308	stream banks		4–5
	Hapton, Lancs.	34/785307	marshy waste ground		4–6
	Milton, Cambridge*	52/466615	waste ground		4–5
telmateia	Coverack, Cornwall	10/786190	flushed stream bank	4	3–4
	Wytham Woods, Berkshire	42/45–08–	spring lines in wood		3–5
	Whalley, Lancs.	34/738363	spring lines in wood		4–5
Section Subvernalia					
sylvaticum	Upper Teesdale	35/890283	banks of R. Tees	4–5	5
	Whalley, Lancs.	34/738363	rough pasture		4–5
pratense	Ben Lui, Argyll.	27/2—2—	base-rich flush	4	–
	Creag an Lochan, Perthshire	27/5—4—	base-rich flush		–
	Rookhope, Co. Durham*	35/9—4—	banks of Rookhope Burn		–
	Holwich Bridge, Teesdale*	35/89–28–	banks of R. Tees		–
Section Aestivalia					
fluviatile	Tarn Hows, Westmorland	34/329996	margins of tarn by inflow stream	6–7	6–7
	Ainsdale, Lancs.	34/298123	dune slacks		5–6
	Whalley, Lancs.	34/737364	overgrown reservoir		4–9
	Thriplow, Cambridge	52/439465	marshy ground around springs		5–6
	Southampton, Hants.	41/39–15–	marshy ground around springs		5–6
palustre	Ben Lawers, Perthshire	48/602382	peaty pools	5–7	6–9
	Tarn Hows, Westmorland	34/332998	peaty flush		5–8
	Ainsdale, Lancs.	34/298123	dune slacks		5–9
	Bledlow, Bucks.	52/774018	around springs in wet meadow		5–8
	Dearnford Fen, Cambridge	52/473500	around drainage ditches		5–9

*Material grown for three years in the Botanic Gardens, Cambridge

The spores of *E. palustre* start to be shed in May and new fertile shoots are then produced continuously throughout the summer. Unlike those of *E. telmateia* and *E. arvense* well established stands of *E. palustre* are almost invariably fertile. Cones are often produced at the tips of lateral branches, on vigorous stems, where cones produced earlier in the year on the main axes have dehisced: the so-called var. *polystachyum*. This phenomenon also occurs on initially sterile stems where the main axis has been damaged. I have seen this polystachyate condition in scattered stems throughout many populations of *E. palustre*. The spores in the cones terminating the lateral branches often fail to mature as do those produced in cones on main axes late in the year.

The non-deciduous European species of *Equisetum* subgenus *Hippochaete* (TABLE 2) appear to have a rather different type of coning behaviour to that seen in the five deciduous species described above. *E. ramosissimum* in its only British station sheds mature spores from June to August. The cones are produced continuously both on the main axis of new shoots arising from the rhizome, and on the tips of branches of different orders on the aerial stems. Many of the spores in the latter cones fail to mature, as was seen in *E. palustre*. The spores in cones produced late in the year often mature in the same season but are not liberated until the following one. The coning behaviour described here is typical of *E. ramosissimum* throughout its world range (HAUKE 1963) even though it is in Britain at the limit of its range and its native status here is doubtful.

In the Weardale colony of *E. hyemale* cones can be found in every month of the year and the spores are liberated from April to September. New fertile shoots are produced throughout the summer, cones on the earlier ones dehiscing the same season but many of those on stems produced later in the year not until the following spring. The spores in these latter cones do however, usually mature in the autumn and will germinate if planted out on agar (DUCKETT 1968). This retention over winter of mature spores also seen in *E. ramosissimum*, appears on the whole, to be confined to the subgenus *Hippochaete*. This type of coning behaviour conforms to that described as typical for *E. hyemale* by Hauke. However, the colony of *E. hyemale* at Southampton exhibits a rather different coning behaviour. Fertile shoots are produced late in the year and the cones, often containing mature spores overwinter, shed their contents the following spring. Occasional cones may be found in the summer but these are dead ones which failed to dehisce in the spring. A third stand of *E. hyemale* at Preston failed to produce any cones during the period 1965–1968.

E. variegatum in Britain seems to exhibit two very different types of coning behaviour which appear to be closely related to the ecology of this species. In basic dune slacks around the coast and in a sandpit near Southampton dehiscing cones may be found from March–October but are most abundant in June and July. New fertile shoots appear to be produced continuously throughout the year. The cones produced early in the spring and summer mature rapidly and shed their spores immediately but those produced late in the year usually overwinter in an immature state and the spores mature the following spring. This behaviour is very similar to that described for *E. variegatum* by Hauke. However, in calcareous mires and base rich flushes in the mountains of Britain *E. variegatum* appears to be scarcely ever fertile. I have seen cones only in September and most of these contained very immature spores.

TABLE 2

Coning behaviour of different populations of *Equisetum* subgen. *Hippochaete* in Britain between 1965 and 1968

Species	Locality	Grid reference	Habitat	Months when spores were shed acc. C.T.W. 1962	Months when spores were shed acc. Hauke 1963	Months when spores were shed obs. J.G.D. 1965–68
ramosissimum	Boston, Lincs.*†	53/3—4—	river bank	7–8	5–8	6–8
hyemale	Cowshill, Yorks.*†	35/85-64-	calcareous flush	7–8	4–9	4–9
	Preston, Lancs.*	34/5—3—	shaded stream bank			–
	Southampton, Hants.*†	41/4—2—	shaded stream bank			4–6
variegatum	Ainsdale, Lancs.	34/300120	dune slacks	7–8	9	3–10
	Newborough Warren, Anglesey*†	23/41-63-	dune slacks			3–10
	Mochras, Merioneth	23/55-25-	dune slacks			3–10
	Chelworth, Hants.*†	41/3—1—	sand pit			3–10
	Malham, Yorks.*	34/9—6—	calcareous mire			9
	Widdybank Fell, Co. Durham*	35/8—2—	calcareous mire			9
	Creag an Lochan, Perthshire*	27/59-40-	calcareous flush			–
	Ben Lui, Argyll.	27/26-27-	calcareous flush			–
	Ben Lawers, Perthshire	27/5—4—	calcareous flush			–

*Material grown for three years in the Botanic Gardens, Cambridge. †Cones produced in pot culture.

Various British Equiseta have been grown in pot culture both outside and in a cool greenhouse for three years in the Botanic Gardens Cambridge (TABLES 1 and 2). The only species to cone in pots with any regularity and abundance was the non-british *E. scirpoides*. This species produced new fertile shoots from April–December. Cones produced early in the year shed their spores later the same season but those produced in the autumn persisted unexpanded until the following spring. This behaviour corresponds exactly to that of *E. scirpoides* in the wild (HAUKE 1963). Of the British species in cultivation no cones were produced by any of them until they had been growing undisturbed for 2–3 years. No cones were produced by any of the pot cultures of *E. pratense* and *E. arvense* and no species produced spores in the cool greenhouse. Cones were produced only on material of *E. hyemale* and *E. variegatum* from colonies which were normally very fertile in the wild.

DISCUSSION

E. arvense, *E. telmateia* and *E. sylvaticum* appear to be very strictly seasonal in their coning behaviour; meiosis, spore maturation and spore liberation are all restricted to specific times of the year. *E. fluviatile* and *E. palustre* have much longer coning periods and new cones may be produced throughout the summer growing season, a phenomenon especially pronounced in *E. palustre*. In all these five deciduous species the spores are liberated almost as soon as they mature.

In the species whose stems overwinter, the coning habits are much less well defined. No specific events appear to be restricted to certain seasons but rather growth slows down or accelerates according to the time of year. The spores on fertile shoots formed early in the year mature rapidly and are shed the same season, but those in cones formed in the autumn, although they may mature the same season, are often retained overwinter before they are liberated.

The coning behaviour of the two rarest British species of *Equisetum*, *E. pratense* and *E. ramosissimum*, is of some interest. Although the former species is undoubtedly native it is rarely fertile, while *E. ramosissimum* whose native status is rather doubtful exhibits the coning behaviour typical of the species throughout its world range.

One of the most fascinating aspects of the coning behaviour of *Equisetum* is the difference which seems to exist between stands of the same species. The three stands of *E. hyemale* listed in Table 2 each had different phenology. In *E. variegatum* two very distinct types of coning behaviour have been found and these were closely related to the ecology of this species. The fertility of *E. arvense* varies greatly from stand to stand within any one area of Britain. Various hypotheses have been put forward to explain this phenomenon. MANTON (1950) states that good coning sites in *E. arvense* are those places with better drainage and fuller illumination than those which suffice for vegetative growth, citing as an example the abundance of fertile material on railway embankments. HAUKE (1966) suggests that genetic differences in fruiting ability may exist between stands, but also indicates that the age of a particular stand (i.e. how much time elapsed since the sexual fertilization which produced it) may also be an important factor in this phenomenon. In *E. hyemale* and *E. variegatum* only material from abundantly fertile wild stands produced cones in cultivation indicating that the fertility differences are not due entirely to ecological or climatic factors. It is possible that genetic differences do exist between stands in coning ability but the possible role of clone ageing cannot be overlooked; indeed this must be considered along with genetic, ecological and climatic factors in any explanation of the great flucutations seen from year to year in the fertility of individual stands of *E. arvense*. Clearly long-term cultivation experiments and detailed field observations are necessary for a full explanation of the phenology of *Equisetum*. In addition, observations should be made on cultures of known age to study possible effects of stand age on fertility. To this end sporophytes, produced by self-fertilization of *E. telmateia*, gametophytes in axenic single spore cultures, have been successfully transferred to soil in the hope that they will eventually produce cones (DUCKETT 1968).

The lack of cone production for 2–3 years after transplanting fertile material of *Equisetum* indicates that disturbance has profound effects on fertility; a hypothesis borne out by the following observations on wild stands. *E. ramosissimum* at Boston, normally produces many hundreds of ripe cones each year. In August 1966 extensive repairs were made to the river bank on which the plant flourishes and in August 1967, although there was no dimunition in vegetative growth only six ripe cones could be found. A stand of *E. telmateia* at Whalley has, for the last six years, produced normal fertile shoots each spring. In 1965 the area was disturbed and the following summer cones were produced at the tips of normal vegetative stems: the so-called var. *serotinum*. The polystachyate condition in *E. palustre* is closely associated with death or damage to the tip of the main axis of a particular stem. Intermediates between sterile and fertile stems have often been reported in *E. arvense* and the occurrence of these is closely correlated with summer frosts (EATON 1899).

These few examples indicate that a wide range of responses may be elicited concerning the coning behaviour of *Equisetum*, a genus well known for the phenotypic plasticity of its vegetative organs. Transplanting usually "switches off" coning, in *E. palustre* damage to aerial stems stimulates it, and the breakdown of the dimorphism between vegetative and fertile stems in *E. arvense* and *E. telmateia* appears to be closely related to disturbance and adverse climatic conditions respectively. Although little is known as yet about the physiology and morphogenetic control of fruiting in *Equisetum* the aspects of the coning behaviour described above suggest that these problems are readily amenable to a wide range of experimental investigation.

I would like to express thanks to Dr K. R. Sporne for his constant help and encouragement while carrying out this work, to the many people who supplied information on *Equisetum* localities, to Professor P. R. Bell for reading and commenting on the manuscript and to my father for use of his car.

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TWO NEW SPECIES OF *PLATYCERIUM* AND THE IDENTIFICATION OF *P. GRANDE* (FEE) PRESL

G. J. DE JONCHEERE* and E. HENNIPMAN**

The identification of the *Platycerium* collections made by the junior author during a botanical expedition to Thailand[1] (for details see HENNIPMAN & TOUW, 1966) necessitated a critical examination of the material from S.E. Asia, in particular the specimens hitherto referred to *P. grande* (Fée) Presl and *P. wallichii* Hook.

It appeared that a new giant staghorn fern occurred in Thailand and Indo-China. Furthermore, when investigating the typification of *P. grande*, it was found that the name *P. grande* is nomenclatorally linked to material from the Philippines, whereas the general conception of *P. grande* has become primarily connected with the well-known Australian plant. The specimens from the Philippines were found to be specifically different from those occurring in Australia and the description of another new species became unavoidable.

P. grande (Fée) Presl, *P. wandae* Raciborski, *P. wallichii* Hooker, *P. coronarium* (Mueller) Desvaux, *P. ridleyi* Christ, and these two new species constitute a natural group within the genus with a coherent geographical distribution.

1. ***Platycerium grande*** ([J. Smith *ex*] Fée) Presl, Epim. Bot. (1852) 154; J. Smith, Hook. J. Bot. 3 (1841) 402, *nom. nud.; auct., excl. specim. Austr.*—*Neuroplatyceros grandis* Fée, Hist. Acrost. (1845) 103, *quoad specim. p.p.*—*Alcicornium grande* Underwood, Bull. Torr. Bot. Cl. 32 (1905) 594, *quoad specim. p.p.*—**Lectotype:** *Cuming 157*, Philippines, Luzon, Mt. Christobal (BM).—PLATE XI.

Rhizome, scales of the rhizome, and sterile leaves unknown. *Fertile leaves* up to c. 55 by 80 cm, coriaceous, green, stalk up to 4 cm long, c. 1 cm thick near the middle, gradually widening distally, woody, striated; *lamina* broadly cuneiform, primarily divided into 2 equal, ± symmetrical lobes separated by a narrow sinus, base of the lamina cuneate, shortly decurrent, base of each lobe 6–13 cm wide, cuneate, gradually widening distally, largely covered by one soral patch below, lowest sinus of each lobe dilated, up to 15 cm wide, entire to somewhat repand, on either side of the soral patch flanked by 3–6 times divided, mostly inwardly orientated, strap-like segments, ultimate lobes measuring up to 12 by 1.5 cm. *Soral patches* about triangular to ob-trapezoid, 4–8 by 8–14 cm, brown, on the primary lobe just below and not quite reaching the sinus; sporangia ± pyriform, 300–400 by 200–275 μm with 19–22 indurated cells. *Spores* of lectotype bean-shaped, brown, smooth, 65–80 by 35–50 μm.

Distribution—PHILIPPINES, Luzon: Mt Christobal, *Cuming 157* (lectotype); Mindanao: Lamboanga, *Whitford BS 9300* (P); Davao, Mt Apo, *Elmer 11183* (L, P); Lake Lanao, *Clemens s.n.*—VI–1905, in herb. Copeland *8533* (MICH).

Ecology: no information available.

Remarks. 1. The species is characterized by its fertile leaves consisting of two about equal primary lobes each with a well-developed soral patch. It is of smaller size than its Australian counterpart which has but one soral patch on its fertile leaves.

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[1] Made possible by grants from the Netherlands Foundations 'Treub Maatschappij' and 'Treub Stichting'.

2. COPELAND (1905, p. 138) reports *P. grande* not only from Luzon (Albay) but also from Ticao Is and Masbate Is. In his latest publication (1960, p. 458) he mentions Mindanao only. In both publications he describes the fertile leaves as having one soral patch.

3. The obvious reason why the herbarium collections of *P. grande* usually show but one soral patch is that the relatively wide fertile leaves are cut in two through the lowest sinus by collectors. In dried material this is difficult to reconstruct. *Cuming 157* is not a freak as was first suggested, but an exceptionally good collection. The dissected leaves usually present in the herbaria are very similar in general appearance to a complete, but small fertile leaf of *P. superbum* (see below) from Australia.

4. Typification. J. SMITH (*op. cit.*), when enumerating Cuming's Philippine collections, identified *Cuming 157* as *P. grande* (*nom. nud.*) referring to a MS name that was used by Cunningham for a collection from Australia. FÉE (*op. cit.*) validly published the species providing a Latin diagnosis and more details in French.

The material upon which Fée based himself comprised *Cuming 157* which he cites as '*exsiccatum*' and to which the French description of the incomplete fertile leaf applies, but also Gaudichaud's collections from the Philippines and Singapore, the later representing *P. coronarium.*

Fée's references include the plate of HOOKER (1842, t. 80B) which represents the Australian species. The protologue of *P. grande* therefore applies to three species.

The name *P. grande* being in general use for the widely cultivated Australian species, preferably a lectotype should have been chosen that unquestionably applies to Australian material. However, UNDERWOOD (*op. cit.* p. 595), who gives full reference to synonyms and illustrations, writes 'type from the Philippines' and TINDALE (1961, p. 28), who personally studied the *Cuming 157* collection, designates *Cuming 157* as the lectotype ('holotype') of *P. grande*, tacitly assuming conspecificity with the Australian material.

Although to be regretted because of its practical consequences, the choice of *Cuming 157* is in accordance with the International Code of Botanical Nomenclature (edition 1966), and it necessitates the description of the Australian material as a new species, no other name being available.

2. ***Platycerium superbum*** Jonch. *et* Hennipm., **spec. nov.**—*P. biforme* Hooker, Gen. Fil. (1842) t. 80B; *non* Blume—*P. grande auct., quoad specim. Austr. solem.* —**Type:** *Cunningham s.n.*, Australia, Queensland, Morton Bay (K).—FIGS 4, 5.

Ex *Platycerii grandis* affinitate, differt foliis fertilibus maioribus in parte basali versus sinum primum (i.e. infimum) dilatatum acervo unico munitis; acervus in utroque latere cum divisionibus multis sterilibus. *P. grande* habet folia fertilia cum sinu prima angusta, acervos duos in parte basali versus sinus secundos. Omnis acervus in utroque latere cum divisionibus paucioribus quam in *P. superbo.*

A detailed description of this species as *P. grande* has been given by many authors, for instance HOOKER (1858, t. 86, *c. descr.*) and by TINDALE (1961). Tindale

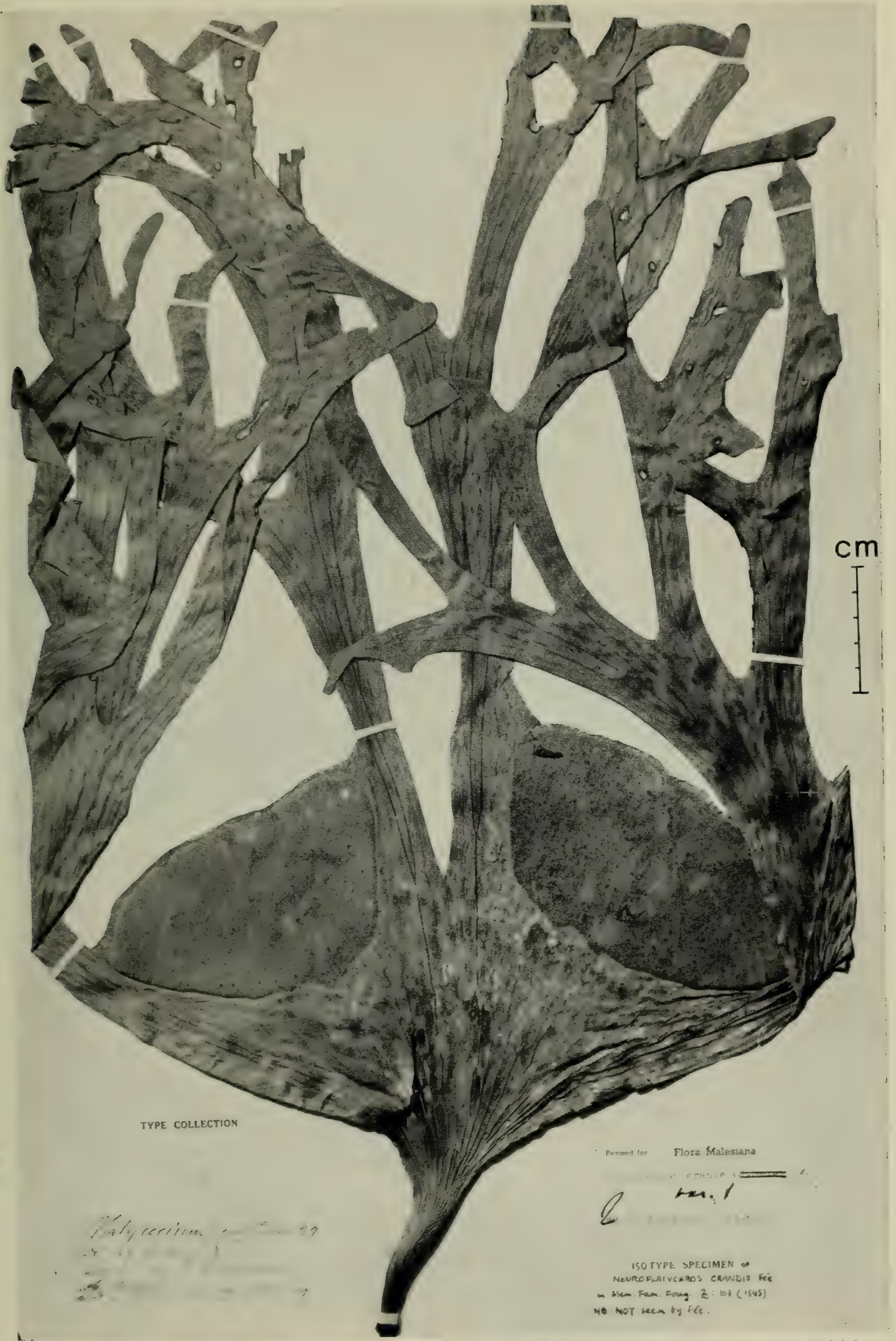

cm
TYPE COLLECTION
Platycerium
Revised for Flora Malesiana
ISOTYPE SPECIMEN of
NEUROPLATYCEROS GRANDIS Fée
in Mém. Fam. Foug. 2: 107 (1845)
NB NOT seen by Fée.

PLATE XI: *Platycerium grande*. Fertile leaf of *Cuming* 157, lectotype (by courtesy of the British Museum, Natural History).

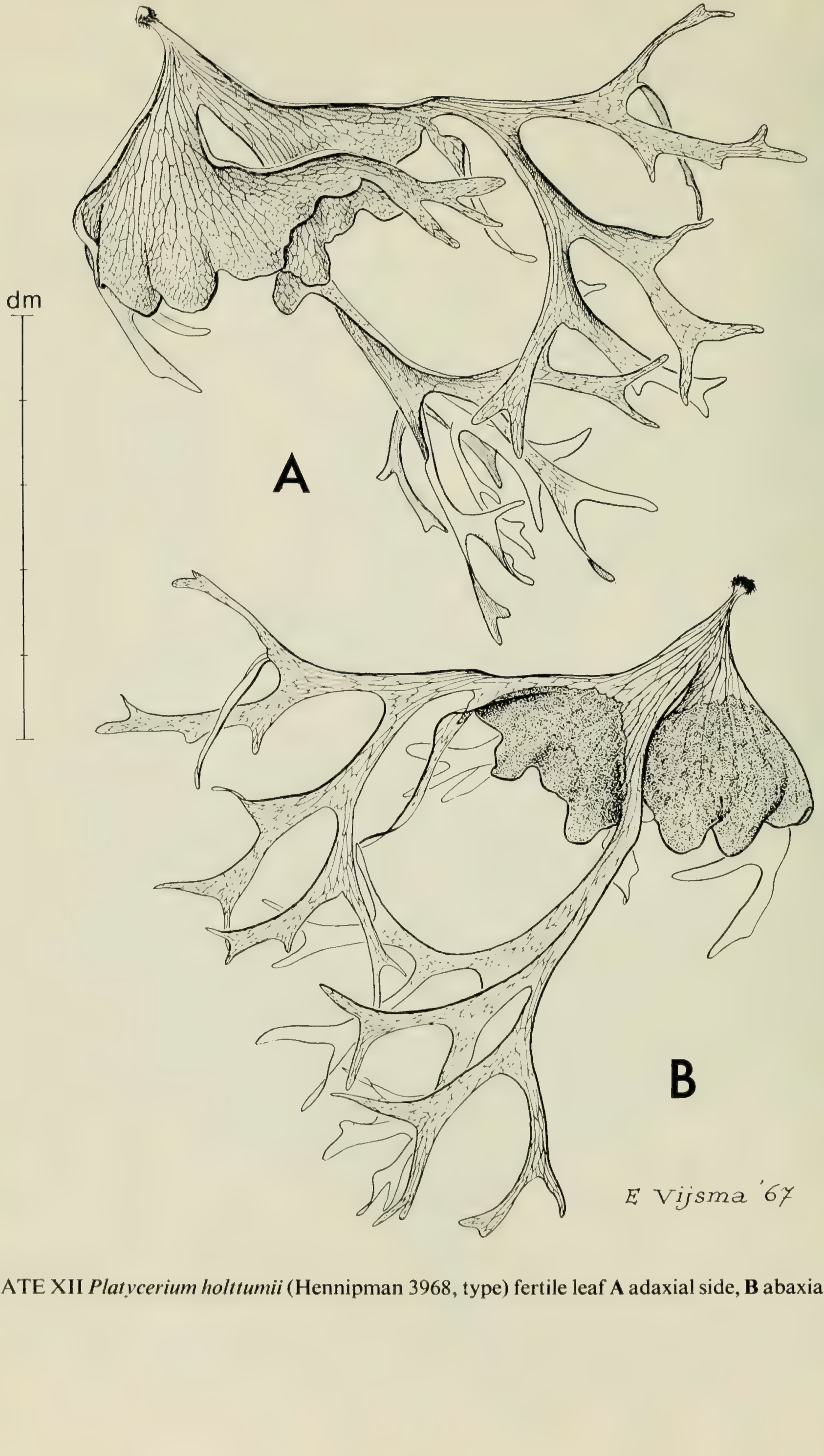
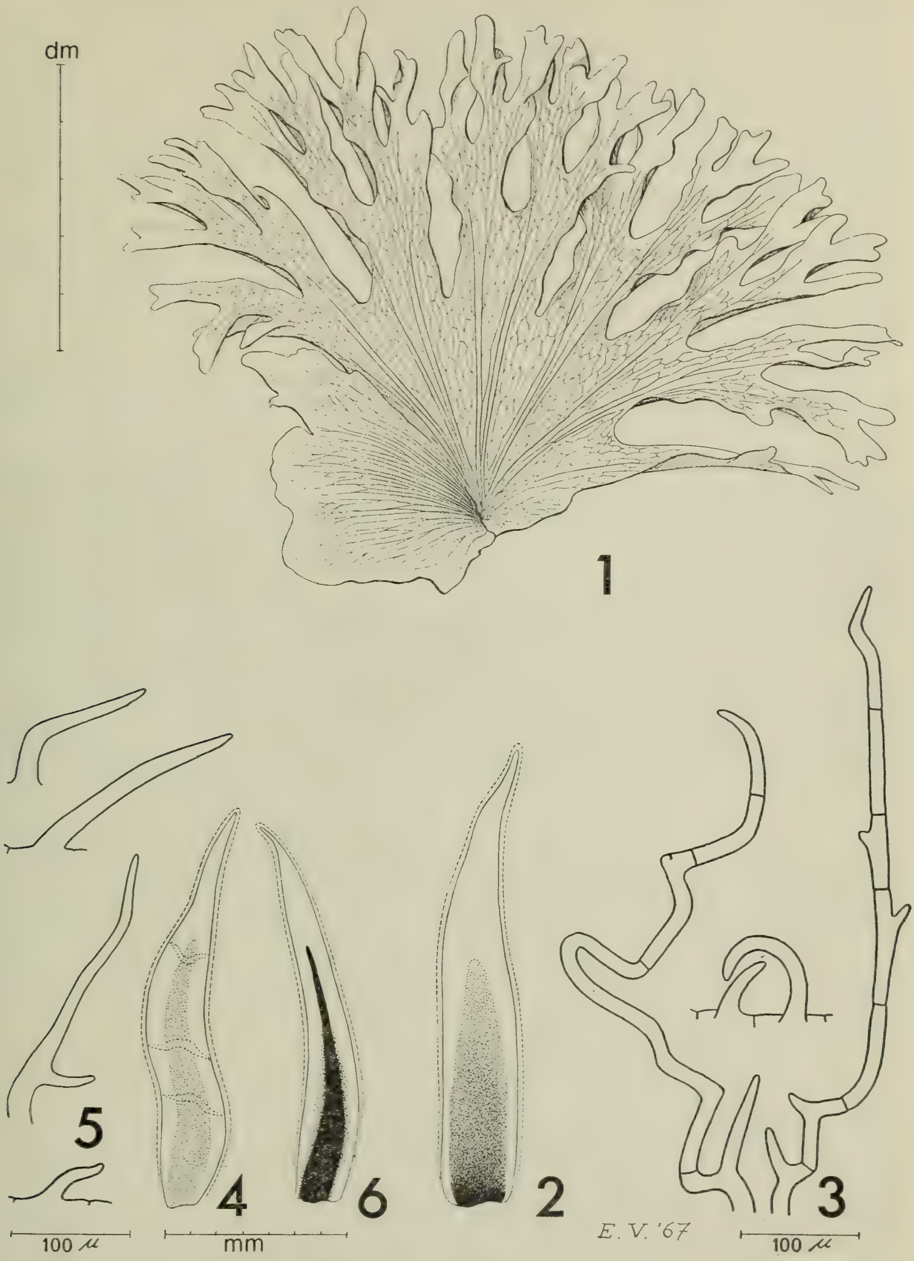


PLATE XII *Platycerium holttumii* (Hennipman 3968, type) fertile leaf **A** adaxial side, **B** abaxial side.



FIGURES 1 – 6: **1** *Platycerium holttumii* (Hennipman 3520) sterile leaf (adaxial side), **2** scale of the rhizome, **3** hairs of the marginal area of the scale; **4** *P. superbum* (Gilbert NSW P-5789, NSW) scale of the rhizome, **5** hairs of the marginal area of the scale, **6** *P. wandae* (Docters van Leeuwen 10181, L) scale of the rhizome.

also gives detailed information about the distribution of wild specimens as well as about their ecology. The only significant addition to the description we can give regards the hairs on the scales of the rhizome. These marginal, branched or acicular, hyaline hairs generally consist of but one or a few cells and are rather similar to those found in *P. wandae*. The general appearance of the scales of these two species is, however, different as the flat scales of *P. wandae* have a markedly pronounced central stripe which is absent in the usually somewhat bullate scales of *P. superbum* (Figs. 4, 5).

3. ***Platycerium holttumii*** Jonch. *et* Hennipm., **spec. nov.—Type:** *Hennipman 3968* (L, holotype; BKF, KYO, isotypes).—*Platycerium grande* Tard.–Blot & Christensen, Fl. Gén. Indo–Chine 72 (1941) 446, *p. maj. p.; non* Presl.—Plate XII & Figs 1–3.

Rhizoma breve dense lepidotum. Rhizomatis squamae 4–8-plo longiores quam latae, usque ad 20 mm longae, 3.5 mm latae, brunneae, in parte centrali fuscae, basaliter insertae, margine pilis plerumque multicellularibus fimbriatae, apice acutae. *Folia sterilia* reniformia c. 90 cm longa, 100 cm lata, lucide viridia, brunnescentia solem cum foliis adultis novellis, sessilia, multilobata, sinubus supra dimidium basin versus productis; lobis patulis, 3–4-plo dichotomis, sinubus angustis praeditis, segmentis ultimis inornatis, apice obtusis; venae anastomosantes, ei prominentes (per paria) in lobos exeuntes. *Frondes fertiles* per paria enati, c. 100 × 125 cm, carnoso-coriacea, lucide virides; stipes c. 3 cm longus, ligneus, striatus, in sectione transversa prope partem centralem ellipticus, sensim dilatatus versus partem distalem; *lamina* pendula, asymmetrica, bifida in divisionibus primariis duabus inaequalibus a sinu angusta sibi separatis; venae anastomosantes cum venis primariis prominentibus margine parallelis; *divisio interior* c. 100 × 100 cm, c. 6-plo dichotoma, sinu infima dilatata c. 30 cm lata undulata irregulariter lobata; in parte proximali sinus infimae subtus pro maiore parte acervo obtecta; segmenta distalia lorata, sensim angustata, segmentis ultimis 10–15 × c. 2 cm; acervus irregulariter triangularis ferrugineus c. 20 × 30 cm; *divisio exterior* 30 × 90 cm, supra divisionem interiorem producta atque horizontaliter superposita 2–3-plo divisa; sinus infima c. 40 cm lata, in parte proximali subtus acervo obtecta; segmenta breviora quam ea divisionis interioris; acervus irregulariter triangularis, c. 35 × 45 cm. Folia utrinque sparse velutina pilis stellatis albidis sessilibus 300–600 μm diam. graciliter 9–14-brachiatis. *Sporangia* stipitata pyriformia, 275–350 μm longa, cellulis induratis 18–20 praedita. Spori fabacei, in sicco subvieti, diametro aequatoriali 75–85 μm, diametro polari 40–60 μm, brunnei, laevia. Paraphyses stellatae stipitatae, 275–400 μm diam. 9–14-brachiatae, stipite c. 0.9 mm longo (Typus).

Rhizome short, densely covered by scales. Scales of the rhizome 4–8 times as long as wide, up to 20 by 3.5 mm, brown with a darker central part, basally attached, marginally fringed with (branched) usually multicellular hairs, apex acute. *Nest leaves* reniform, c. 90–100 by 100–135 cm, bright green, long-lived, becoming brown only when new leaves have developed, sessile, divided into many lobes, the deepest sinuses reaching more than half-way to the base, lobes spreading, 3–5 times dichotomously divided, with narrow sinusses, ultimate segments rather coarse with blunt tips; venation anastomosing with prominent veins (in pairs) running to the lobes. *Fertile fronds* produced in pairs, c. 100–125 by 125–175 cm, fleshy-coriaceous, bright green; stalk c. 3 cm long, woody, striated, in cross-section near the middle elliptic, gradually widening distally; *lamina* pendent, asymmetrical, primarily divided into two unequally-sized lobes which are separated by a narrow sinus, base of the lamina broadly cuneate, venation anastomosing with some prominent main veins running parallel to the margin; *interior lobes* c. 100–125 by 100–125 cm, six times about dichotomously divided, the lowest sinus dilated, c. 30–35 cm wide, undulate, irregularly lobed, soral patch produced proximally of lowest sinus, distal segments strap-like, gradually narrowing, ultimate segments up to 20(–3) by 2(–3) cm, soral patch irregularly triangular, rusty brown, c. 20 by 30–35 cm; *exterior lobe* 30–35 by 90–120 cm, jutting out horizontally over interior lobe, 2–4 times divided, lowest sinus c. 30–40 cm wide, segments shorter than those of the interior lobe; soral patch irregularly triangular, c. 20–35 by 35–45 cm. Indument: leaves on both sides thinly covered by a felt of whitish, sessile, stellate hairs measuring 300–600 μm in diam., with 9–14 slender arms. *Sporangia* stalked, pyriform, 275–350 μm long, with 18–20 indurated cells. Spores of type bean-shaped, in dried material somewhat shrivelled, equat. diam. 75–85 μm, polar diam. 40–60 μm, brown, smooth. Paraphyses stellate, stalked, 275–450 μm in diam., with 9–14 arms, stalk c. 0.9 mm long.

Distribution: Thailand, Indo-China.

THAILAND. Southwestern, Kanchanaburi, Erawan National Park between Khwae Noi and Mae Klong rivers, c. 200–300 m alt.: *van Beusekom s.n.*—IV–1968 (in cultivation in the Botanic Garden, Leiden, nr. *16638*); Northeastern, Udawn, near Ban Na Luang, c. 101° 25′ E, 17° 25′ N, c. 370 m alt.: *Hennipman 3520* (BKF, KYO, L); Eastern, Nakohn Ratchasima, Khao (Mt) Yai National Park, c. 101° 30′ E, 14° 30′ N, c. 500 m alt.: *Hennipman 3968* (type).

INDO-CHINA: *Eberhardt 11* (P). Laos: *Poilane 2411* (P, W); near Luang Prabang, c. 700 m alt.: *Poilane 20354* (P). Cambodia: *Poilane s.n.*, –1928 (P). Cochin-China: *Pierre s.n.*, –V–1867 (P); *Thorel 1512* (P); near Bien Hoa, Gia-ray: *Poilane 2538* (P, W).

Ecology: Heliophilous epiphyte in monsoon forest.

This giant fern has been named after Dr R. E. Holttum, Kew, England, with sentiments of highest regard and in acknowledgement of his important contributions to the knowledge of the ferns of the Asian tropics.

Remarks 1. The English description has been drawn from the three complete collections available (all from Thailand). The other collections cited were either fragmentary or too much folded for obtaining reliable measurements from the mounted material.

2. *P. holttumii* is characterized by its large asymmetrical leaves which bear two soral patches. As regards its leaf-architecture it seems closely related to *P. wandae* of New Guinea. However, the outer primary lobe of the fertile leaf of *P. wandae* has a much more developed stalk and has no, or rarely a but once divided, sterile segment distally of the soral patch; the hairs on the scales of the rhizome are very similar to those of *P. superbum*.

3. Apart from *P. wandae*, *P. wallichii* may be a source of confusion, especially as this species is partly sympatric. *P. holttumii* and *P. wallichii* were found by van Beusekom growing intermingled in southwestern Thailand. However, the sterile leaves of *P. wallichii* are smaller and short-lived, which makes it easy

to discriminate between the species in the dry season; the fertile leaves also are shorter and have a different leaf-architecture: apart from the two primary lobes with each a suborbicular lobe seating the soral patches, a third sterile outer one is always present.

ACKNOWLEDGEMENTS

The senior author is indebted to Mme Dr Tardieu-Blot for the hospitality received during a short visit to the Paris Herbarium in 1967. We are grateful to Dr R. C. Bakhuizen van den Brink Jr who provided the Latin descriptions of the new taxa and to Mr A. C. Jermy, British Museum (Natural History), London, for kind co-operation in various ways.

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REVIEW

PLATYCERIUM—FERN FACTS, by Wendy Franks, 108 pages, 55 half-tone pictures (by Ed. Franks). 14×21.5 cms. Published by the author, 1121 Hidden Lane, La Habra, California 90631. Price $4.50+15c postage+23c California State sales tax for California residents.

This delightful book is based on the author's wide experience at home and with the Los Angeles International Fern Society, and on the help she received from Mrs Hoshizaki and her monograph (Barbara Joe in Baileya 12. 1964).

We are given three Sections: (I) Introduction, (II) The 17 known species and their cultivars, with photos and descriptions, (III) Culture. Seven unnamed variants (pp. 75–81) are described and figured, with details of their affinities, and one unnamed variant of *P. bifurcatum* is described (p. 30). One unnamed new species (p. 69) is said to be allied between *P. grande* and *P. wandae* (*wilhelminae-reginae*), and in the index is entered as '*P. willinckii* cultivar unnamed new species'. 'P. Wietz grande' (p. 39) could perhaps be better named *P. grande* 'Wietz'.

The format is a pleasant typescript illustrated in black-and-white half-tone and with effective underlining of diagnostic words. For the staghorn fern grower this is a 'must'.

J. A. CRABBE

THE PTERIDOPHYTES OF FLORES (AÇORES): A SURVEY WITH BIBLIOGRAPHY*

C. M. WARD**

INTRODUCTION

In the summer of 1967 a group of students of several science disciplines from Chelsea College (University of London) set out for Flores and Corvo in the Portuguese islands, Açores. In eight weeks on Flores I collected 34 out of the 40 taxa in my list. Politically the westernmost point of Europe, Flores is the most westerly of the group of volcanic peaks forming the Açores, lying midway between Europe and the Americas (long. 31° 12′ W.; lat. 39° 27′ N.) and being approximately 1250 miles from either land-mass. With its satellite Corvo it is separated from the main group of islands by 140 miles of sea.

The island consists of a volcanic peak composed mainly of basaltic lava. Superimposed on the volcano are a number of volcanic necks and cinder cones. There are also deposits of ash and pumice but only small amounts of sediments, still unconsolidated, exist derived from the volcanic rocks. Some of the volcanic cones contain craters which have filled with water to form caldera lakes several hundred feet deep. Although minor volcanic eruptions have occurred in the other islands in recent times there has been no recorded activity on Flores in historic times and hot springs are the only indication of present vulcanism. Erosion, in its early stages, is rapid resulting in high cliffs, deep ravines with cascading waterfalls and rugged peaks. Access to the island is gained up lava slopes on whose lower levels are situated the larger villages with their intensive agricultural areas. Apart from these arable areas which occupy only 18% of the island, and apart from cattle grazing, the vegetation of Flores is natural and undisturbed.

The relative humidity is high with an average of 85%. The mean annual precipitation between 1921 and 1950 was 57.00 inches at the main town, Santa Cruz and 71.41 inches at Ponta Delgada a village on the north-east point. The lack of extreme temperatures and the high humidity typical of a maritime climate, produces an environment favourable to the luxuriant growth of ferns.

THE PTERIDOPHYTES OF FLORES

The classification and nomenclature is based on *Flora Europaea*

(E) = endemic to the Açores
(GC) = living plant from Flores growing at Chelsea Physic Garden
(GW) = spore progeny growing with C. M. Ward
★ = new record for Flores
(locality, etc., field number) = Ward specimen at BM

Lycopodiaceae

HUPERZIA SELAGO subsp. DENTATA (Herter) Valentine. Collected from the mossy central plateau (Fazenda de Santa Cruz, Delgadinho—Pico da Sé, 450 m, *39*) where it grew through a dense 6–8 inch layer of *Sphagnum*.

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*Research for this paper was completed during a vacation studentship at the British Museum (Natural History) in the summer of 1969.

**Dept. of Agricultural Botany, University of Reading.

HUPERZIA SELAGO subsp. SUBERECTA (Lowe) Romariz. Growing where the bog spills over the steep sides of the caldera (Caldeira da Lomba, 650 m, *42*).

> **Notes: 1.** my specimen *39* exhibits variable toothing in the leaves, ranging from almost non-existent, which suggests there may be no real difference between these two subspecies.
>
> **2.** The specimen (which I have not seen) quoted as *Lycopodium inundatum* by ALLORGE & ALLORGE (1946, text-fig. to plate IV–2, and 1948, p. 136) and TARDIEU-BLOT (1946, p. 340) was seen by Alston (DANSEREAU 1961, p. 154) and identified by him as *L. selago* subsp. *suberectum.*

DIPHAZIUM MADEIRENSE (Wilce) Rothm. Not found by me.

> **Note:** In her description of *Lycopodium madeirense* Wilce (WILCE, 1961) cites six paratypes for the Açores, among which is *Trelease 1245* (isoparatypes at BM, US, MO, K) collected on Flores in 1894 on the mountains above Lagens and listed (TRELEASE 1897) as *L. complanatum.*

Selaginellaceae

SELAGINELLA KRAUSSIANA (G. Kunze) A. Braun (**GC**). Ubiquitous as extensive mats in woods, fields and calderas (Caldeira Comprina, 540 m, *48*).

> **Note:** BAKER (1883, p. 210) described *S. azorica* but ALSTON (1956b) considered it conspecific with *S. kraussiana;* more work is needed.

Isoetaceae

ISOETES AZORICA Durieu ex Milde (**E**). Growing in the shallows of the lakes in two of the calderas, Rasa and Lomba (Caldeira da Lomba, 650 m, *41*). It was browsed on and pulled loose in large quantities by the carp which have been introduced, and was washed ashore as a rim on the beaches of both lakes. The other lakes are sheer-sided and do not provide a suitable habitat.

Equisetaceae

EQUISETUM TELMATEIA Ehrh. Found in all the coastal ravines examined. Some specimens were within a metre of the high tide mark in bouldery deposits at the mouth of the Ribeira da Cruz (Caveira, 1 m, *17*). Mostly it was found in muddy ground along river banks, but the best specimens were in marshes at the base of the cliff-line around Fajazinha.

Ophioglossaceae

OPHIOGLOSSUM AZORICUM C. Presl. Found in only one location, although in large numbers, in a grassy field on the cliff-top overlooking Fajazinha (Cabouca, 430 m, *49*).

Osmundaceae

OSMUNDA REGALIS L. Widely distributed and common in woods, ravines, caves by waterfalls (Sabateira, Santa Cruz, 450 m, *6*), cliffs of the calderas down to the lake-side, and sea-cliffs to a few feet above sea-level.

Adiantaceae

ADIANTUM CAPILLUS-VENERIS L. Not found by me.

> **Note:** It has been recorded for Flores by VASCONCELLOS (1968b), and whether it is alien or native is a debatable point.

A. RADDIANUM C. Presl (**GC, GW**) may well have 'escaped', as it is frequently kept as a pot-plant. It was found in a number of locations around Santa Cruz, including the wall of the school-house where we lived. Although found in a number of damp walls (Santa Cruz, 13 m, *2*), this species grew best by the side of the Ribeira do Pomar near Santa Cruz (Lameiro, 30 m, *14*) where a group of several hundred plants was found in a steep-sided gulley overhung by trees, the delicate fronds falling in cascades down the rock-face.

> **Note:** There has been considerable confusion between this species and *A. capillus-veneris* and many records for the former may be of this species.

Pteridaceae

PTERIS SERRULATA Forsk. Grows widely in gulleys, field-margins and stream-sides (Ribeira das Casas, Faja Grande, 30 m, *22*), also on the cliffs and gentler slopes of the calderas.

Dicksoniaceae

CULCITA MACROCARPA C. Presl (**GW**). I saw only a few individuals on the sides of valleys, for instance of Ribeira Grande and near Lagens (southern Caldeira Funda, 530 m, *43*), but I was told that it grows commonly in the hills around Lagedo where the fronds are gathered annually as decoration for a festival.

Hypolepidaceae

PTERIDIUM AQUILINUM (L.) Kuhn. Common everywhere in undisturbed soil along field-margins (Santa Cruz, 20 m, *16*), in woods, the central plateau, and calderas. It competes with *Woodwardia radicans* for dominance in a number of habitats, but seems to prefer a deeper soil.

Hymenophyllaceae

HYMENOPHYLLUM TUNBRIGENSE (L.) Sm. Found in several damp, well shaded habitats under rock overhangs in Caldeira Seca near Pico da Sé (Fazenda de Santa Cruz, Delgadinho, 400 m, *38*), and also around the base of clumps of *Erica azorica* (Caldeira Branca, 550 m, *51*) on the central plateau.

H. WILSONII Hooker has been reported several times for Flores, e.g. ALLORGE & ALLORGE (1948), as an epiphyte on *Erica*, but I was not able to find it.

TRICHOMANES SPECIOSUM Willd. Common in damp shaded places forming thick swards over rocks and the bases of tree-trunks in woods, e.g. near Fajazinha (Faja Grande, Topo Poço, 450 m, *27*), also in caves around the plunge pool of a waterfall (Sabateira, Santa Cruz, 450 m, *8*), under rock overhangs, and at the base of walls.

Thelypteridaceae

★THELYPTERIS LIMBOSPERMA (All.) H. P. Fuchs. A group of plants was found on the grassy slopes of Caldeira Comprida (540 m, *46*) and also on the roadside nearby.

T. POZOI (Lag.) C. V. Morton. Only one specimen was found, in thin water-logged soil on the cliff-face of Caldeira Comprida (540 m, *45*).

CYCLOSORUS DENTATUS (Forsk.) Ching. Found in a number of locations along the banks of streams (Ribeiro do Pomar, Lameiro, Santa Cruz, 30 m, *13;* Lomba, 130 m, *32*).

Aspleniaceae

ASPLENIUM HEMIONITIS L. (**GW**). Mainly in dry stone walls particularly around Santa Cruz (Vigia, Fazenda de Santa Cruz, 100 m, *15*), but was also found on one occasion in ground made soft by the spray from a waterfall (Ribeira das Casas, Faja Grande, 50 m, *20*).

A. MARINUM L. (**GC, GW**). Common to within a few feet of the high tide mark in cliffs and walls close to the sea (Santa Cruz, 8 m, *1*), also near the southern Caldeira Funda, 4 kms from the sea at a height of 550 m.

A. MONANTHES L. has been recorded for Flores but was not found by me. During the expedition it was collected on Corvo by Philip Pryor *no. 175* (BM).

A. TRICHOMANES subsp. QUADRIVALENS D. E. Meyer (**GC, GW**). Not common but was found in walls (Coada, Faja Grande, 200 m, *26;* Boca da Baleia, Lagens, 350 m, *37*) and in weathered cinder deposits around the island.

A. BILLOTII F. W. Schultz (**GC, GW**). Growing well on cliffs and walls near the sea (Santa Cruz, 13 m, *3*) with *A. marinum*, but did not extend so far inland.

A. ADIANTUM-NIGRUM L. (**GW**). Occurred in stone walls and rocky ground in a number of locations but was not common (Faja Grande, 20 m, *35*).

PHYLLITIS SCOLOPENDRIUM (L.) Newman (**GC**). Found on only a few occasions, growing best in damp woods around Fajazinha (grassy bank near waterfall, Ribeiro das Casas, Faja Grande, 50 m, *21*).

Athyriaceae

ATHYRIUM FILIX-FEMINA (L.) Roth (**GC, GW**). Common in woods and shaded gulleys in the calderas, central plateau and valleys (grassy slopes, southern Caldeira Funda, 400 m, *34;* streamside, Morro dos Frades, 560 m, *40*).

DIPLAZIUM CAUDATUM (Cav.) Jermy (**GW**). Was mainly restricted to woodlands and was particularly well developed around Fajazinha (Topo Poço, Faja Grande, 230 m, *28*) but was also in clearings on the banks of the Ribeira Grande.

D. ALLORGEI Tardieu-Blot (**E, GC, GW**). Found in natural habitats in a number of shaded situations in gulleys and on stream-banks around Santa Cruz (tree-covered deep ravine of the Ribeiro do Pomar, Lameiro, 30 m, *12;* shaded stream-bank, Lameiro, 50 m, *18*) and Faja Grande (bank of the Ribeira das Casas, 30 m, *23*).

> **Notes: 1.** Before my visit *D. allorgei* had been recorded for S. Miguel (TARDIEU-BLOT 1938) but not for Flores. Subsequently VASCONCELLOS (1968b) gave Faial, Flores, Pico and S. Miguel. JERMY (1964) suggested it might have been introduced from South America, but in 1969 (pers. comm.) thought it should be regarded as endemic to the Açores.
>
> **2.** The following anatomical observations may be of interest: the vascular strands of the rhachis have two bundles at the base fusing to form a single semi-circular strand (usual for *Diplazium*); there are glandular or paraphysis-like cells on the sporangial stalks; the indusial margin terminates in linear multicellular hairs; the frond is densely covered with linear, multicellular, colourless hairs with a few branched ones on the lower surface. Repeated attempts to observe meiosis in spore mother cells failed.

CYSTOPTERIS FRAGILIS (L.) Bernh. Growing in clefts in cliffs around the calderas (southern Caldeira Funda, 400 m, *36*) and in waterlogged soil on dripping cliffs in the valley of the Ribeira Funda (Lomba, 140 m, *33*).

Aspidiaceae

POLYSTICHUM SETIFERUM (Forsk.) Woynar (**GC, GW**). Widespread as scattered individuals in the ravine of the Ribeira Funda and in banks by roads and paths (Alminhos, Santa Cruz, 250 m, *9*).

> **Note:** No. 9 and the plant at Chelsea Physic Garden differ from the usual in being more coriaceous, with conspicuously crowded, almost overlapping, obtuse pinnae and pinnules. Other specimens at the British Museum, (Natural History), from Madeira and the Canaries, are similar.

CYRTOMIUM FALCATUM (L.f.) C. Presl (**GC, GW**). Seen on a number of inaccessible cliff ledges near Santa Cruz (Baixa do Moinho, Caveira, 10 m, *19*) and Fajazinha, but it was seen at its best at the mouth of the Ribeira Grande (5 m, *31*) where in the loose rock and pebble deposits many hundreds of plants of different ages were found.

Unlike some other islands, there is no botanic garden on Flores, so the presence and dispersal of *C. falcatum* was almost certainly natural.

DRYOPTERIS PSEUDO-MAS (Woll.) Holub et Pouzar (**GW**). Uncommon on grassy banks in some of the shallower calderas (Caldeira Branca, 550 m, *50*) and on the banks of the Ribeira Grande (Inhame Vermelho, 550 m, *44*).

★D. AZORICA (Christ) Alston (**E**). Grew best in the Fajazinha woods, but was also found on the slopes of the northern Caldeira Funda (550 m, *47*).

> **Notes: 1.** It was raised to specific rank by ALSTON (1956a, p. 14, with errors in citation) from *Aspidium dilatatum* var. *azoricum* CHRIST (1907).
> **2.** Alston considered that *D. azorica*, with its more finely cut fronds, its small ovate rhachis scales, its narrower, darker (purplish, almost obliterating the central strip) rhizome scales, is allied to *D. dilatata*. However, its spore architecture and fine frond-cutting are similar to those of *D. assimilis*, and the purplish colour in the stipe suggests *D. aemula*. Cytological investigation could show, as I suspect, that *D. azorica* is a diploid member of the *D. dilatata* complex.
> **3.** *D. austriaca* (Jacq.) Woynar (*D. dilatata* (Hoffm.) A. Gray) has been recorded by several authors but I think it likely that it is all *D. azorica*.

D. AEMULA (Aiton) O. Kuntze (**GW**). Widespread and profuse in woods (Castanheiro, Santa Cruz, 450 m, *10;* Topo Poço, Faja Grande, 250 m, *29*), valleys, calderas (grassy slopes, southern Caldeira Funda, 400 m, *35*), and the central plateau.

Elaphoglossaceae

ELAPHOGLOSSUM HIRTUM (Swartz) C. Chr. has been reported from Flores but I was not able to find it. ALLORGE & ALLORGE (1948) record it growing epiphytically on trees in Caldeira Comprida and Caldeira Sêca,

Blechnaceae

BLECHNUM SPICANT (L.) Roth. Growing on walls and banks (Chao do Reblo, Santa Cruz, 200 m, *5*), in woods and calderas, and on the central plateau.

WOODWARDIA RADICANS (L.) Smith. In similar habitats to the preceding, but much more densly to the exclusion of other vegetation. It was the dominant plant in many woods (on slopes in ravine of tributary of the Ribeiro dos Barqueiros, Charneca, Santa Cruz, 160 m, *11*, *30*) and calderas, and its fronds often shrouded the inland cliffs.

Polypodiaceae

POLYPODIUM AZORICUM (Vasc.) R. Fernandez (**E, GW**). Was common usually on tops of walls (Santa Cruz, 8 m, *4*), on roadside banks (Pico da Casinha, Santa Cruz, 430 m, *7*), and occasionally on trees.

Notes: Açores specimens of *Polypodium* were at first allocated to *P. vulgare* L. and later to *P. australe* Fée. BOBROV (1964), using the *P. vulgare* var. *teneriffae* Milde as type, named *P. macaronesicum* from the Canaries. VASCONCELLOS (1968a) described *P. vulgare* var. *azoricum* from the Azores. FERNANDEZ (1968) pointed out the affinity of *P. azoricum* to *P. australe* rather than *P. vulgare*, and also distinguished between *P. azoricum* and *P. macaronesicum* (both may be separated from *P. australe* by having (11–) 12–16 indurated annulus cells).

In my specimens, in those of Drouet (BM) and in *P. macaronesicum* (type-collection BM) I find the characters used to separate *P. azoricum* and *P. macaronesicum* unreliable. Fernandez uses a dark stripe on the rhizome scales of *P. macaronesicum* and this character is described and photographed by Bobrov; however, the BM specimen shows no stripe and, moreover, some specimens of *P. azoricum* showed a faint stripe. Another character used is the shape of the pinnule-tip, but this was found to range from obtuse to acute in both species. The only useful characters I found were the frond shape (ovate-triangular in *P. azoricum* and more lanceolate in *P. macaronesicum*) and rather stronger teeth on the scales of *P. azoricum*. Further examination of a larger amount of material, and particularly cytological work, is required.

DISCUSSION AND SUMMARY

Although Flores appears to have been little studied botanically, some lists of pteridophytes have been published. While looking for records of Flores pteridophytes I compiled the bibliography of relevant literature for Açores pteridophytes which follows.

Flores measures only 7 by 10 miles (12 × 16 kms) and I was not able to study it all in detail. For this reason I selected areas which included all types of habitat.

The number of fern taxa on Flores is small (40) because of the limited variation of climate and habitats and the isolation from large land masses (2000 km from Portugal or America) and other islands (1700 km from the Canaries).

Cultivated ferns on the island were mostly *Adiantum raddianum* and *Nephrolepis* among the many popular pot-plants, as there were no botanic and few private gardens.

Of the 40 taxa in my list two marked with an ★ have not previously been recorded for Flores (four others are recorded only by VASCONCELLOS 1968b), five marked (**E**) are endemic to the Açores, 25 are also found in Europe (20 in Britain). The world-wide distribution of the Açores ferns and the possible modes of colonization are discussed by several authors, e.g. PALHINHA (1943).

My list also cites the 50 herbarium specimens presented to the British Museum (Natural History) and indicates living material at Chelsea Physic Garden (**GC**) and with me (**GW**). Spores for growing have been taken from suitable specimens, to add to the living material which is all available for cytological study.

ACKNOWLEDGMENTS

Grateful thanks are due to the following: The British Museum (Natural History) for awarding me a Vacation Studentship and to A. C. Jermy and J. A. Crabbe, for help and advice both before and since the expedition; the Chelsea College governors and other bodies for financial backing; and Chelsea Physic Garden for so ably tending the living ferns. Accommodation on the island was provided by the padre of Santa Cruz, in the school, using beds from the hospital and I am grateful to the islanders for their hospitality.

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There are some photographs of Flores vegetation in ALLORGE 1946, as follows: au-dessus de Caldeira Comprida (t. 1, f. 3), Caldeira Agoa branca (t. 2, f. 1), Morro Grande (t. 2, f. 2), gros bombement de Sphaignes envahi par le Polytrichum commune (t. 2, f. 3), Asplenium marinum and A. palmatum at Fajazinha (t. 3, f. 2), between Lages and Lagedo (t. 3, f. 3), Woodwardia radicans at Fajazinha (t. 4, f. 4).

REVIEW

FLORA DER SCHWEIZ UND ANGENZENDER GEBIETE VOL. 1 PTERIDOPHYTA—CARYOPHYLLACEAE by H. E. Hess, E. Landolt and R. Hirzel, 558 pp., 9 maps, illustr. 23.5×29.5×6.4 cms. Birkhäuser Verlag, Basel & Stuttgart, 1967. Price 118 Swiss francs (approx. £12).

This volume (the first of three) contains a systematic treatment of the Pteridophyta (pp. 96–161), Gymnosperms, Monocotyledons and Dicotyledons up to Caryophyllaceae (based on Engler & Prantl's system). There are, on the whole good, keys to genera and species, and after a concise description of the species there are paragraphs on cytology (with references), distribution and critical notes on relationships and taxonomic status of each plant. The layout, although wasteful of space, is attractive and clear; the illustrations by Rosmarie Hirzel are beautiful but sometimes unnecessarily too small and of herbarium specimens rather than of living plants. Nevertheless the diagnostic features are usually clearly depicted.

The area covered is somewhat larger than Switzerland, extending from the Franche-Comté to Merano and from the southern Vosges to northern Dauphiné. In all, 91 fern taxa are treated, including all except nine British taxa. Nomenclaturally it leaves much to be desired, e.g. *Equisetum maximum* (for *telmateia*), *E. limosum* (for *fluviatile*), *Pteris longifolia* (for *vittata*), *Polystichum lobatum* (for *aculeatum*) and *Polypodium serratum* Willd. (non Aublet) for *P. interjectum*. There are even greater misconceptions in the taxonomy. *Gymnocarpium* is sunk into *Thelypteris* (for which the illegitimate name *Lastrea* is used); *Gymnocarpium* is related to *Dryopteris* but not even close to *Thelypteris*. *Polypodium virginianum* is said to be conspecific with *P. australe* on grounds of interfertility, which is doubtful. I agree with treating *Notholaena marantae* as such, rather than sinking it in *Cheilanthes*, but the two genera should have been placed together; placing *Notholaena* between *Ceterach* and *Phyllitis* (in my opinion both=*Asplenium*) is unacceptable.

This book has size and price against it. Nevertheless it contains a lot of useful data and should be referred to by any worker on the British pteridophyte flora.

A. C. JERMY

AN INTRODUCTION TO THE FERNS OF JAPAN*

ANNE SLEEP**

INTRODUCTION

Japan consists of four main islands covering an area approximately one-and-a-half times the size of the United Kingdom. It occupies a similar area in the eastern half of the northern hemisphere and, like the British Isles, is situated in a somewhat isolated position abutting a major ocean on the edge of a continental land mass. In spite of the similarity of their geographical position, however, their floras are strikingly different, as may be seen by quoting some statistics with regard to the ferns. In Britain some 70 taxa of ferns and fern-allies are recognised (JERMY 1960) while a conservative estimate of the number of Japanese pteridophytes is approximately 400 (TAGAWA 1959). Other estimates give the number as between 700 and 1,000 (NAMEGATA & KURATA 1961, SUGIMOTO 1966), but this depends partly on the number of varieties, forms and hybrids which the author is prepared to recognise! However, it is nevertheless apparent that Japan supports a very rich flora in proportion to its size, and we may usefully comment here on some of the factors influencing this circumstance.

Japan is in fact situated much further south than the British Isles, Tokyo being on the same latitude as Malta. The islands stretch out in a long chain, extending over some 15° of latitude from 30° in the south to over 45° in the north. The land area is approximately 850 miles in length, and extends from subtropical to subalpine zones, which results in a variety of climatic conditions not usually found in other island groups. In addition, some 70% of the total land mass of Japan consists of a complex system of mountains, many extending to over 3,000 m (c. 10,000 ft) in altitude. The mountainous topography combined with the geographical position have thus resulted in the unique selection of diverse habitats which are to be found throughout the archipelago. The close proximity of the sea produces an insular climate over much of the country. The warm Black Stream, or Japan Current, flows from south-west to north-east along the Pacific side of the islands, and influences all southern and south-eastern areas, giving them a relatively high rainfall and little or no frost in the parts near the coast. In these southern areas are to be found many plants which occur principally in areas further south. Similarly, in the north, the cool Kurile current has a pronounced cooling

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*I should like to take this opportunity of thanking publicly all those kind friends and colleagues, too numerous to mention individually, who have so generously given up their time to guide me in many interesting localities in both near and distant parts of Japan. From each of them I have learnt much, and to all I tender my most grateful thanks.

A particular debt of gratitude is due to Professor H. Ito for his criticism of the manuscript and for writing the section on Ryukyu ferns, as well as for his generous help and constant encouragement. I also wish to acknowledge with thanks the pertinent suggestions of Dr K. Iwatsuki and the unfailing interest and help of Professor S. Kurata. It is my pleasure to record here my indebtedness to Professor H. Takeda, for his kindness in allowing me to reproduce some of his excellent drawings and photographs of Japanese ferns, and for his valuable advice.

In conclusion I wish to express my deep gratitude to the Science Research Council in London for the financial support which made my stay in Japan (1967–69) possible, and in this connection I extend my thanks both to Professor Ito and to the authorities of Tokyo University of Education for granting me facilities in the Botany Department of that institution.

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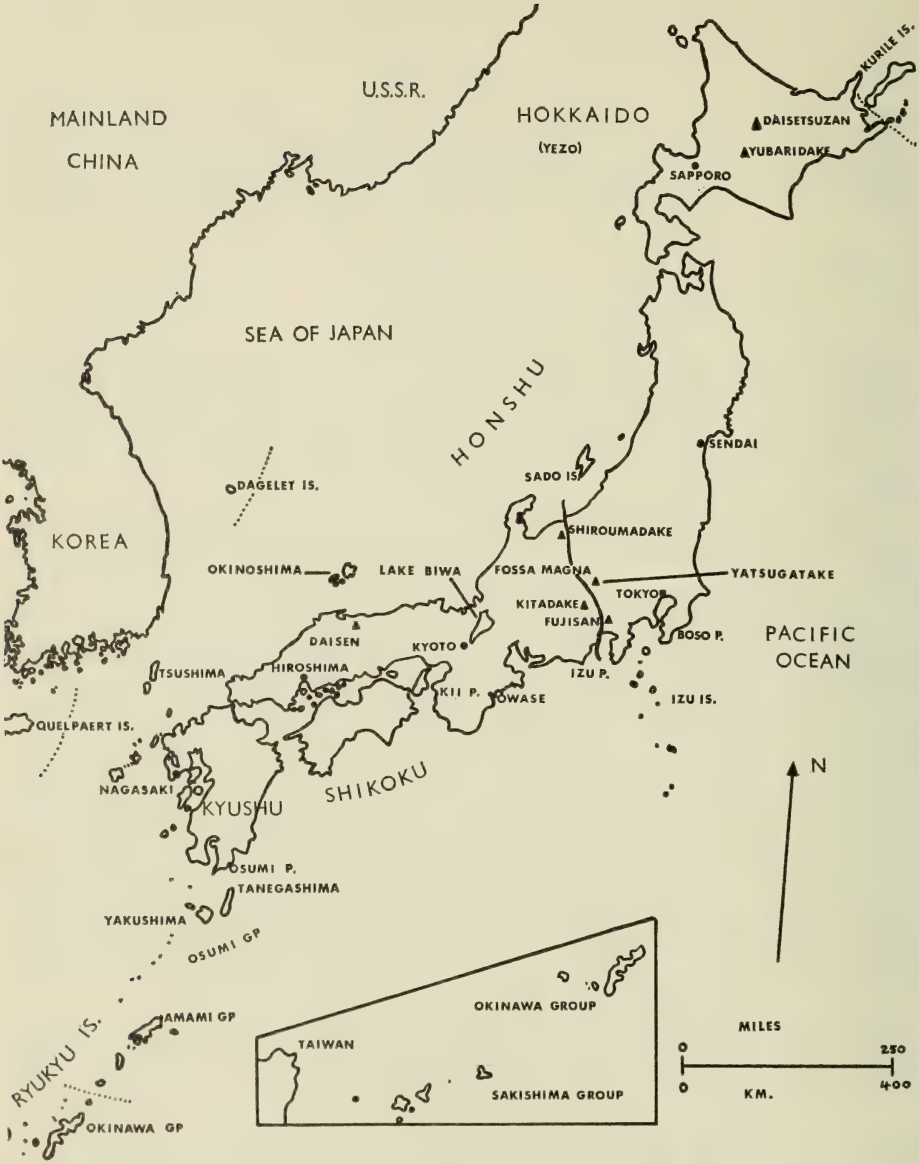

FIGURE 1. The Japanese archipelago. Note: shima = island, while —yama, —dake, —take, —san, —zan and —sen may all be translated as 'mountain' or 'peak'.

effect on the climate of northern Honshu, and in the northern regions and on the higher mountains many boreal species occur which extend into this area from more northerly latitudes.

The flora of Japan is most closely related to that of China, and approximately 75% of the pteridophytes are common to the Chinese mainland. This is hardly surprising in view of the fact that the Japanese islands were a part of the continental land mass of Asia, at least until the Quaternary period. The plants show a close relationship to similar entities occurring in the mountains of China, where many species exist as relicts of the much older Tertiary floras. It is an interesting fact that Japan was not greatly affected by the Pleistocene glaciations, which have undoubtedly been responsible for the severe depletion of the British flora in geologically recent times. Older floras have thus been preserved in Japan while they have vanished from other areas.

The vegetation shows a strict altitudinal zonation, from the alpine summits of the numerous mountain peaks to the subtropical belt of the southern areas. We shall now consider these vegetational zones in more detail.

ALPINE REGION

In the central part of the main island of Honshu the alpine zone begins at altitudes of about 2,500 m. It extends from about 2,000 m in northern Honshu, and from 1,500 m in Hokkaido. Characteristically, the alpine zone is represented by a shrubby pine, *Pinus pumila*, except on the more recent volcanoes such as Mt Fuji (where it is replaced by a dwarf form of *Larix leptolepis*). Immediately below the *Pinus pumila* zone deciduous shrubs are much in evidence, and include *Betula ermanii*, *Alnus maximowiczii*, *Prunus nipponica*, *Sorbus sambucifolia*, *S. matsumurana*, etc. These are mixed with many high altitude dwarf shrubs and herbaceous plants which, as in Europe, principally include members of the Ericaceae, Primulaceae, Gentianaceae, Cyperaceae, and so on. The alpine region is well-developed only in parts of the northernmost island of Hokkaido (e.g. Mt Daisetsu, Yubaridake) and on some of the higher peaks in central Honshu. Ferns are restricted to rock-crevice species, and they include many rarities. The genera of the alpine zone are mostly those having a wide distribution throughout the northern parts of the northern hemisphere, and indeed, the majority of pteridophyte species found in this zone are representatives of widely distributed circumpolar species, namely: *Lycopodium selago**, *L. complanatum*, *L. alpinum*, *Selaginella helvetica*, *S. selaginoides*, *Botrychium lunaria*, *B. simplex*, *B. lanceolatum*, *B. multifidum*, *Cryptogramma crispa*, *C. stelleri* (Plate XIIIA), *Woodsia ilvensis*, *W. glabella*, *Athyrium alpestre* (Plate XIIIC), *Dryopteris fragrans*, *Polystichum lonchitis* and *Asplenium viride*. Many of these taxa will be familiar to European botanists, for the majority have a distribution including Japan, Sakhalin, the Kurile islands, Kamchatka, north Korea, Manchuria, Siberia (sometimes via China and the Himalayas), to northern Europe, and North America. *Dryopteris fragrans* (Plate XIIIb), here distinguished as var. *remotiuscula*, is interesting for it descends to quite low levels in Hokkaido where it can be found on rocks close to the sea. *Polystichum lonchitis* is extremely rare in Japan, and few botanists have ever seen it. It grows at high altitudes (over 3,000 m) on Mt Kitadake in the southern alps of Honshu.

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*With the exception of *Botrychium*, the nomenclature in this paper follows Tagawa (1959), although this does not necessarily indicate acceptance by the present author of all the names quoted therein. Particularly questionable are the use of *Lastrea* (for *Thelypteris*) and *Polystichopsis* (for the genus to which the names *Rumohra*, *Arachniodes* and *Byrsopteris* have variously been applied).

Many species of alpine plants found in Japan occur also in eastern Siberia, and sometimes extend to Kamchatka, the Aleutian islands and Alaska, although the pteridophytes having this type of distribution pattern are few in number, for example: *Lycopodium sitchense* var. *nikoense.*

Surprisingly little relationship is shown between the alpine plants of Japan and those of the Sino-Himalayan region, although in this connection it is interesting to note that many high-altitude plants centred in China and the Himalayas do extend to alpine regions of the island of Taiwan, and a number of ferns, for example *Polystichum prescottianum* and *P. thomsonii,* show such a distribution. A Himalayan species which does occur in Japan is the simply-pinnate *Polystichum lachenense.* This fern was first discovered in Japan by Professor H. Takeda in 1903, at an altitude of over 2,500 m in the Yatsugatake mountains. It is an extremely rare plant, and is known only from a few very high peaks in central Honshu. The accompanying drawing (Plate XIV) was prepared by Prof. Takeda, and it shows very well the thick bundle of persistent leaf-bases which cover and perhaps serve to protect the rhizome. The terminal pinna which persists at the tip of each of the previous year's fronds is another characteristic feature of this most interesting plant.

SAXICOLOUS SPECIES

Some interesting rock-crevice ferns occur throughout the cool-temperate parts of Japan, and as their distribution is influenced more by the availability of suitable habitats than by altitudinal zonation I shall treat them together in this section. Some, such as *Asplenium viride* and *Woodsia glabella,* occur chiefly in subalpine regions in Japan. Perhaps the most interesting examples among the rock-crevice ferns are *Asplenium ruta-muraria, A. capillipes* and *Gymnocarpium jessoense.* These ferns can all be found, in company with the above-mentioned two species, at altitudes from 1,700 to 2,000 m on limestone crags in central Honshu. In this particular locality they occur at the limit of temperate forest, where the vegetation usually consists of shrubby components of the following genera: *Picea, Larix, Pinus, Acer, Betula, Prunus, Viburnum* and *Sorbus.* Of these ferns, *Asplenium capillipes* is confined to Japan and Taiwan, while the others have circumpolar distributions. Although often found on limestone, most of these species are not restricted to it, and *Gymnocarpium jessoense* can also occur on serpentine and on volcanic rocks. *Asplenium ruta-muraria* is the only one which is strongly calcicolous, and indeed, it is the most characteristic species of limestone districts throughout Japan and Taiwan. It often occurs in exposed and sunny crevices where no other ferns are to be found. *G. jessoense* is particularly interesting, for although some authors regard it as a distinct species, others (e.g. OHWI 1965) regard it as an eastern Asian variant of the European *G. robertianum.* Further study is necessary to elucidate the matter. Frequently accompanying the above taxa on base-rich rocks in the cool-temperate region (although also widespread on other types of rock and extending to the warm-temperate region) is a simply-pinnate *Polystichum, P. craspedosorum,* which reproduces vegetatively by means of proliferous buds produced at the tips of the fronds.

A fern rarely found on acidic rocks in mountainous districts is the Polypodiaceous *Crypsinus veitchii.* This member of the genus, although it extends as far south as Shikoku, has a predominantly northern distribution centred in Hokkaido and montane parts of Honshu, in contrast to the other Japanese representatives which are of more southern affinity. Another wide-spread rock-crevice fern in northern parts of Japan is *Pyrrosia linearifolia.* This occurs at lower altitudes, usually in the cool temperate (i.e. deciduous) forest zone, although it extends to warm-temperate regions.

BOREAL REGION

This is characterised by a coniferous forest belt, which occurs at altitudes up to 2,000 m in the western parts of Honshu and Shikoku. In central Honshu the zone occurs from 1,500 to 2,000 m altitude, while in the northern districts of the main island it is found from 1,000 to 1,500 m. It descends to near sea level in the northern and eastern parts of Hokkaido. The component elements are somewhat different in Hokkaido and Honshu, the dominant trees in the main island being *Abies mariesii*, *A. homolepis*, *A. veitchii*, *Larix leptolepis* and *Tsuga diversifolia.* Deciduous trees common in this region include species of *Acer*, *Alnus*, *Betula* and *Sorbus*, with *Rhododendron* and *Euonymus* contributing to the shrub layer. Dwarf bamboos belonging to the genus *Sasa* form an almost impenetrable ground cover. The pteridophytes occurring in this region are mostly species having a wide circumboreal distribution and they include *Botrychium virginianum*, *Phegopteris polypodioides*, *Gymnocarpium dryopteris*, *Polystichum braunii* and *Lycopodium annotinum*, all of which are common. In Hokkaido and throughout much of Honshu *Dryopteris austriaca* is a constant and widespread constituent of the ground cover in boreal forests, and the question of any possible relationship of this taxon to the European *D. dilatata* complex is a most interesting one. The Japanese plants are characterised by the possession of creeping white stolons, from which the common name of 'shirane-warabi'—'the white root bracken'—is derived.* Two varieties have in fact been recognised (var. *oblonga* and var. *deltoidea*) but the distinction between them is slight and numerous intermediates occur (Ito, pers. comm.). It is apparent that, like its European counterpart, Japanese *D. austriaca* is extremely variable.

A similar problem occurs in *Athyrium*, where a name originally applied to European plants has been attached, with little comparative investigation, to a fern of similar appearance growing in Japan. It seems to me doubtful that true *A. filix-femina* occurs in this country, although Ohwi (1965) records *A. filix-femina* var. *longipes* as widespread. This taxon is presumably synonymous with *A. brevifrons*, a species with pale brown scales which is common in the north of Japan, particularly in Hokkaido. Its relationships are very obscure, and in the south of the country it tends to be replaced by the very common and presumably related *Athyrium melanolepis*, a very distinct species bearing characteristic ebony scales on the lower part of the rhachis. This taxon is locally common and appears to be endemic to Japan. Further investigation of both these problems is highly desirable.

In addition to these circumboreal species, other ferns having a predominantly north-east Asian distribution (north Korea, north China, Manchuria and parts of eastern Siberia) are common constituents of the flora. They include

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*Although an alternative origin may be Mt Shirane, in Nikkô, where *D. austriaca* is particularly common.

Athyrium crenatum var. *glabrum*, *A. spinulosum*, *A. pycnosorum* (which is widespread throughout Japan), *A. pterorachis*, *Lastrea quelpaertensis*, *Cornopteris crenulatoserrulata*, *Polystichopsis miqueliana*, *P. mutica* and *P. standishii.* The latter fern is very common throughout the coniferous and deciduous forest zones, while at higher altitudes (up to 2,000 m) *P. mutica* (Plate XV) is of ubiquitous distribution. This fern often grows where there is a thick ground cover of *Sasa* spp. and it seems to indicate poor soil conditions. It is usually accompanied by *Dryopteris austriaca* and *Plagiogyria matsumureana*, another species having a north-east Asian distribution and which is a common fern in shady coniferous forests. Two Asiatic species of *Lycopodium* widespread in the montane parts of Japan are *L. obscurum*, a particularly attractive arborescent species, and *L. chinense.*

Sometimes found on trees in the coniferous zone is *Mecodium wrightii*, which can occur up to altitudes of about 1,700 m. This is the most northerly member of the Hymenophyllaceae, and it extends to Hokkaido, Sakhalin and Korea. It has also been found in North America (IWATSUKI 1961). The three endemic species of *Struthiopteris* (Blechnaceae) also have a wide distribution in boreal forests, *S. niponica* being common. *S. amabilis* occurs mainly in the temperate deciduous forest zone, while the third species, *S. castanea*, is characteristically found in coniferous woods on the Japan Sea side of Honshu. A number of fern species are of more frequent occurrence in these western districts, and among them both *S. castanea* and *Cornopteris crenulatoserrulata* (Athyriaceae) are worthy of mention. On rock outcrops throughout both the coniferous and deciduous forest zones two species of *Woodsia* are of almost ubiquitous distribution. *W. manchuriensis* usually prefers shaded situations at lower elevations, while *W. polystichoides* is very common on exposed rocks in mountainous districts. Both species are calcifuge and have a north-east Asian distribution.

Four particularly interesting taxa of rather rare occurrence in the coniferous zone are *Polystichum microchlamys*, *Dryopteris amurensis*, *Cystopteris sudetica* and *Pleurosoriopsis makinoi*. The first is usually considered endemic to Japan, although it is very probably identical with the plant described by Christensen (in HULTEN 1927) as *P. braunii* var. *kamschaticum* (see MIYABE & KUDO 1930). It is a distinctive species, occurring sporadically in coniferous forests in Hokkaido and northern and western parts of Honshu. The southern limit of its range is Mt Daisen (see Fig. 1), where it occurs near the summit of the mountain at the border between deciduous and coniferous forest zones (c. 1,600 m alt.). The vegetation has a subalpine appearance, which is presumably the result of the high winter snowfall (see below). The dominant vegetation is the low-growing shrub *Taxus cuspidata* var. *nana*, accompanied by herbaceous plants more commonly found further north. *P. microchlamys* hybridises with the widespread *P. retrosopaleaceum*, and such plants often attain a very large size.

Dryopteris amurensis is a rare species occurring elsewhere only in Sakhalin and Amur. It shows a relict distribution in Japan, although it may be found growing in abundance in the now rare virgin coniferous forest (mainly consisting of *Picea glehnii* and *Abies sachalinensis*) in the northern and eastern parts of Hokkaido (Tatewaki, pers. comm.). It is possibly related to the *D. dilatata* complex.

Cystopteris sudetica is also a very rare fern, although it can occasionally be found in quantity in coniferous forests in central Honshu. This is yet another relict species showing a disrupted distribution in the northern hemisphere, occurring sporadically in north Korea and Siberia, and extending to parts of northern Europe.

Pleurosoriopsis is an isolated monotypic genus of uncertain affinity. It has been placed by some authors in the *Asplenium* series next to the genus *Pleurosorus* (HOLTTUM 1949), while others (e.g. COPELAND 1947) regard it as closer to the Gymnogrammoid ferns. It is of rare occurrence in Japan and north-east Asia, where it is usually to be found in coniferous forest in montane districts, although it extends to both temperate and warm-temperate regions. It grows in shady, damp places on rocks, often being almost completely buried in a luxuriant growth of various bryophytes.

TEMPERATE FORESTS

The temperate region begins at about 1,000–1,500 m above sea level in Kyushu and southern Shikoku, thence gradually decreasing in altitude north-eastward. It begins at about 500 m in Honshu, descends to sea level at a latitude of about 38°N, and continues northwards along the coastal areas to the south-western part of Hokkaido. The flora of these parts of Japan shows a close relationship to that of certain areas of mainland eastern Asia, especially to the mountainous areas of southern Korea, the lowlands of central Korea and the Huan River valley, the mountainous regions of central China and the high mountains of the Himalayas and Malaysia.

The zone is characteristically marked by the presence of *Fagus crenata*, and other deciduous trees common throughout the region belong chiefly to the following genera: *Acer*, *Aesculus*, *Betula*, *Carpinus*, *Castanea*, *Fraxinus*, *Prunus* and *Sorbus*. The widespread distribution of species of maple throughout this region is responsible for some of the glorious colours to be seen in the autumn. In montane areas *Larix leptolepis*, *Abies homolepis*, *A. firma*, *Tsuga sieboldii* and *Taxus cuspidata* are some of the coniferous trees also represented. Broad-leaved evergreen shrubs, deciduous shrubs (such as *Hydrangea*, *Weigela* and *Vaccinium*) and deciduous lianas are much in evidence. *Cryptomeria japonica* is widely cultivated here, as in the warm-temperate zone, and dense stands of this stately tree clothe many hillsides.

Common ferns widespread in regions of temperate deciduous forest are *Osmunda japonica*, bracken (*Pteridium aquilinum* var. *latiusculum*), *Polystichum retrosopaleaceum*, *P. tripteron* (a very common species, the form found in Hokkaido and the northern parts of Honshu being somewhat different in morphology from the southern form), *Dryopteris crassirhizoma*, *D. monticola*, *D. tokyoensis*, *Athyrium vidalii*, *A. niponicum*, *A. pycnosorum*, *A. yokoscense* (an extremely common and variable fern), *A. squamigerum*, *Leptogramma mollissima*, *Matteuccia orientalis*, *M. struthiopteris*, *Adiantum pedatum* (a delicate and attractive species), *Dennstaedtia hirsuta* and *Coniogramme intermedia*.

The endemic *Polystichum retrosopaleaceum* is widespread in northern and western parts of Honshu and in Hokkaido, and it fills a similar woodland niche to that of *P. setiferum* in Britain. Species of *Lepisorus* (a Polypodiaceous genus centred on eastern Asia) occur commonly as epiphytes in both temperate and warm-temperate regions. *L. thunbergianus* is ubiquitous, even in towns and villages, and two species often found in temperate forests are *L. annuifrons* and *L. ussuriensis* var. *distans*. Another widespread and very common fern of temperate regions is *Asplenium incisum*, which is superficially very similar to the European *A. fontanum*. It is found on rocks and walls, both in woods and near human habitation, and it is often accompanied by *Lepisorus thunbergianus* and *Athyrium yokoscense*. Indeed, *A. incisum* may frequently be seen in Tokyo, where it occurs on walls together with *Cyrtomium fortunei* and the widespread *Pteris multifida*.

The coastal areas of the Japan Sea side of Honshu from Lake Biwa northwards (Hokuriku region) contrast rather sharply in climate with areas of the Pacific coast at the same latitude, the winters being considerably more humid than those of the Pacific side, with very heavy snow in the mountains and in the coastal districts. The flora of the Hokuriku region tends to be richer than in other cool-temperate parts of Japan, and we have already noted that certain ferns are to be found more commonly here than on the Pacific side of Honshu. The fern flora of this area is a unique combination of both northern and southern species and, indeed, many ferns more characteristic of the warm-temperate regions of western Japan extend into this area, for example *Diplazium hachijoense* and *Diplaziopsis cavaleriana*. This may be attributed partly to the high precipitation, and partly to the protective covering of deep snow in winter.

The close affinities that exist between the flora of Japan and that of similar temperate regions of eastern North America were first elucidated by GRAY in 1859. Several controversial theories have been put forward to explain this floristic relationship, one of the best-known being the postulation of a former land bridge which is said to have connected Asia and North America across the Bering Sea in pre-glacial times.

Particularly good examples of ferns occurring in both eastern Asia and in eastern North America are *Polypodium virginianum*, *Cryptogramma stelleri* (Plate XIIIA) and *Adiantum pedatum*. Sometimes the members of a genus common to both areas are so different as to be separated as distinct species, as in the case of *Camptosorus sibiricus* and *C. rhizophyllus*, but often the American taxon and its Japanese counterpart are so similar in morphology that they are either recognised as one broad species, as in the case of *P. virginianum*, or separated only as varieties, for example, *Osmundastrum cinnamomeum* var. *fokiense*, *Onoclea sensibilis* var. *interrupta* and *Lycopodium sitchense* var. *nikoense*.

Sometimes there is a difference in chromosome number, and the circumboreal *Phyllitis scolopendrium* may be cited as a particularly good example, for the taxon is uniformly diploid throughout Europe, and tetraploid in both Japan and in eastern North America (EMMOTT 1964).

WARM – TEMPERATE REGION

This area comprises the lowland parts of southern Honshu, Shikoku and Kyushu, which have a warm-temperate (sometimes subtropical in the coastal areas) climate influenced by the warm Japan (Black Stream) Current from the south-west Pacific Ocean. The well-distributed heavy precipitation, which usually amounts to more than 60 inches per annum in this region, results in a lush vegetation containing many plants of more southern affinity. The conditions are ideal for ferns, and, indeed, some 80% of the pteridophyte flora of Japan is to be found in these warm and humid southern areas.

The vegetation is rich, and consists mainly of broad-leaved evergreen trees

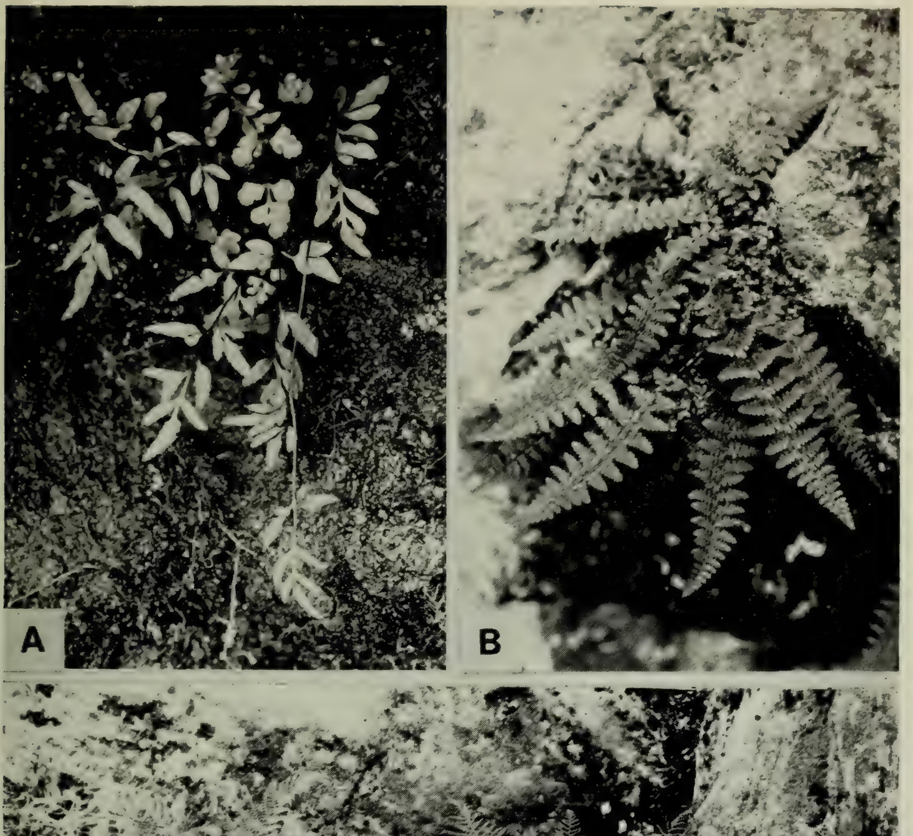

PLATE XIII—Some ferns of the alpine region. **A:** *Cryptogramma stelleri.* Yatsugatake, Nagano prefecture, Honshu. c. one-third natural size. **B:** *Dryopteris fragrans* var. *remotiuscula.* Yatsugatake, Nagano prefecture, Honshu. c. one-quarter natural size. **C:** *Athyrium alpestre.* Mt Shirouma, Nagano prefecture, Honshu. c. one-twelfth natural size. All photographs taken by Prof. H. Takeda.

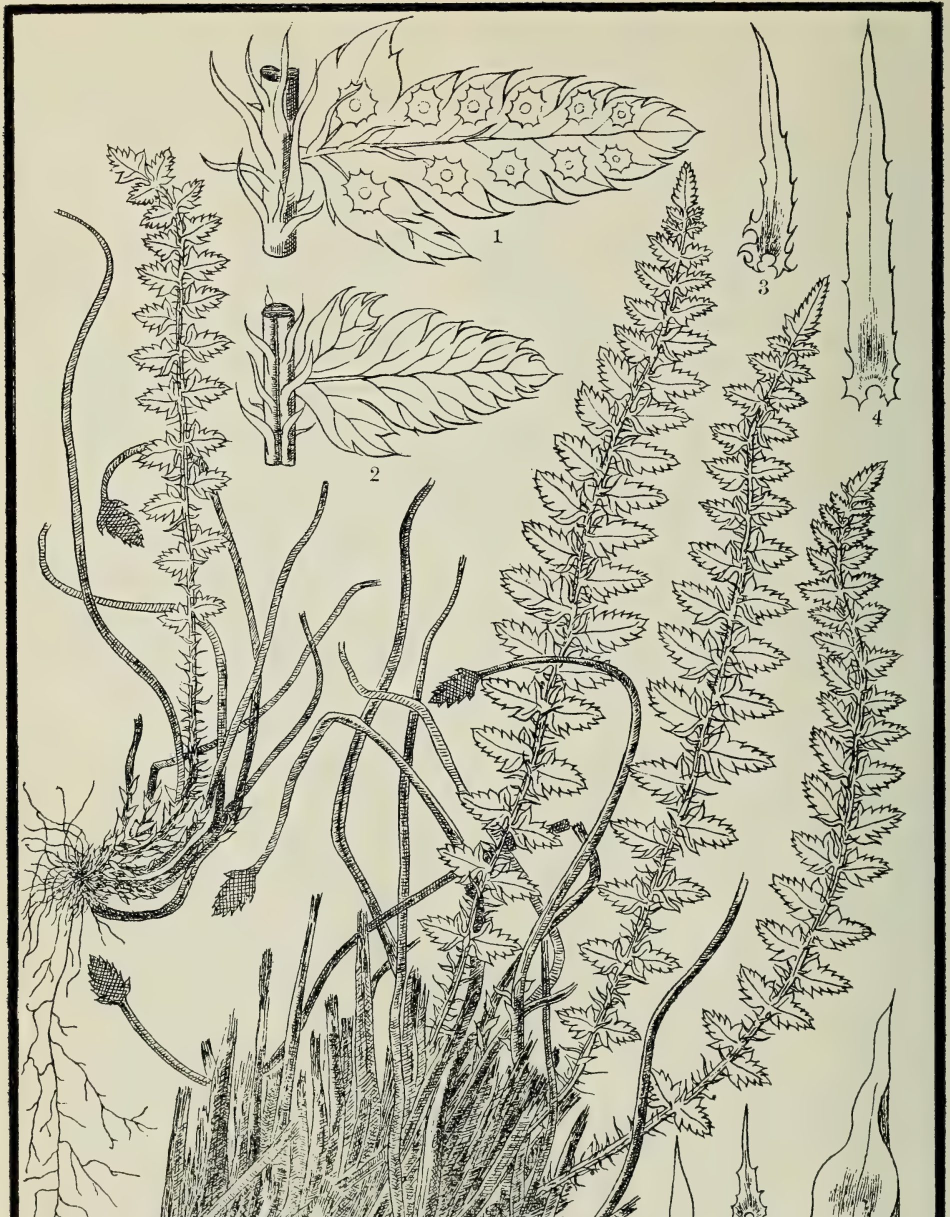
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PLATE XIV—*Polystichum lachenense.* Natural size. Drawn by and reproduced here by kind permission of Prof. H. Takeda.

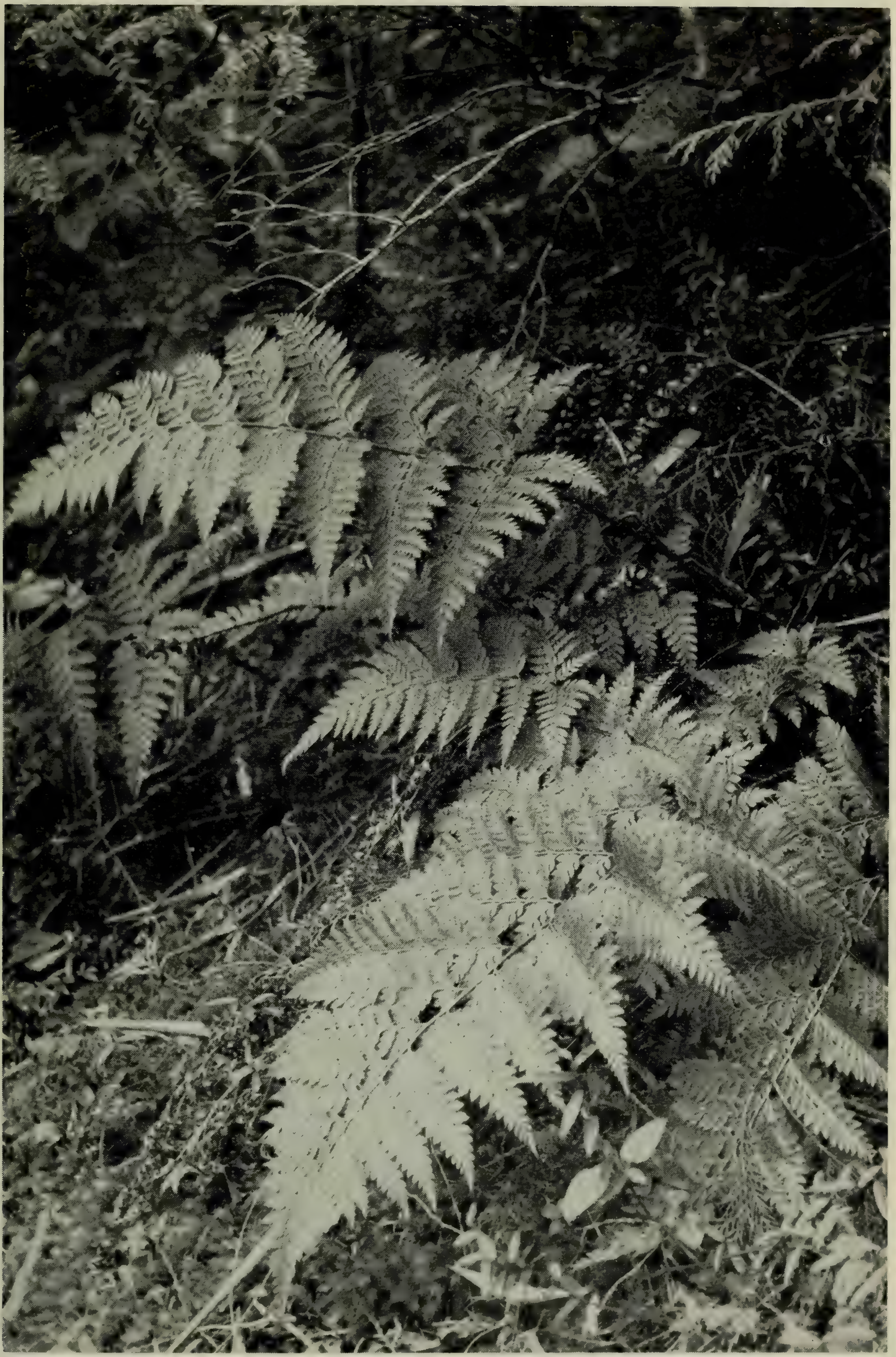

PLATE XV—*Polystichopsis mutica*, a common fern in coniferous forests. Mt Shiraga, Kochi prefecture, Shikoku. c. 1/7th natural size. Photograph taken by Prof. M. Tatewaki.

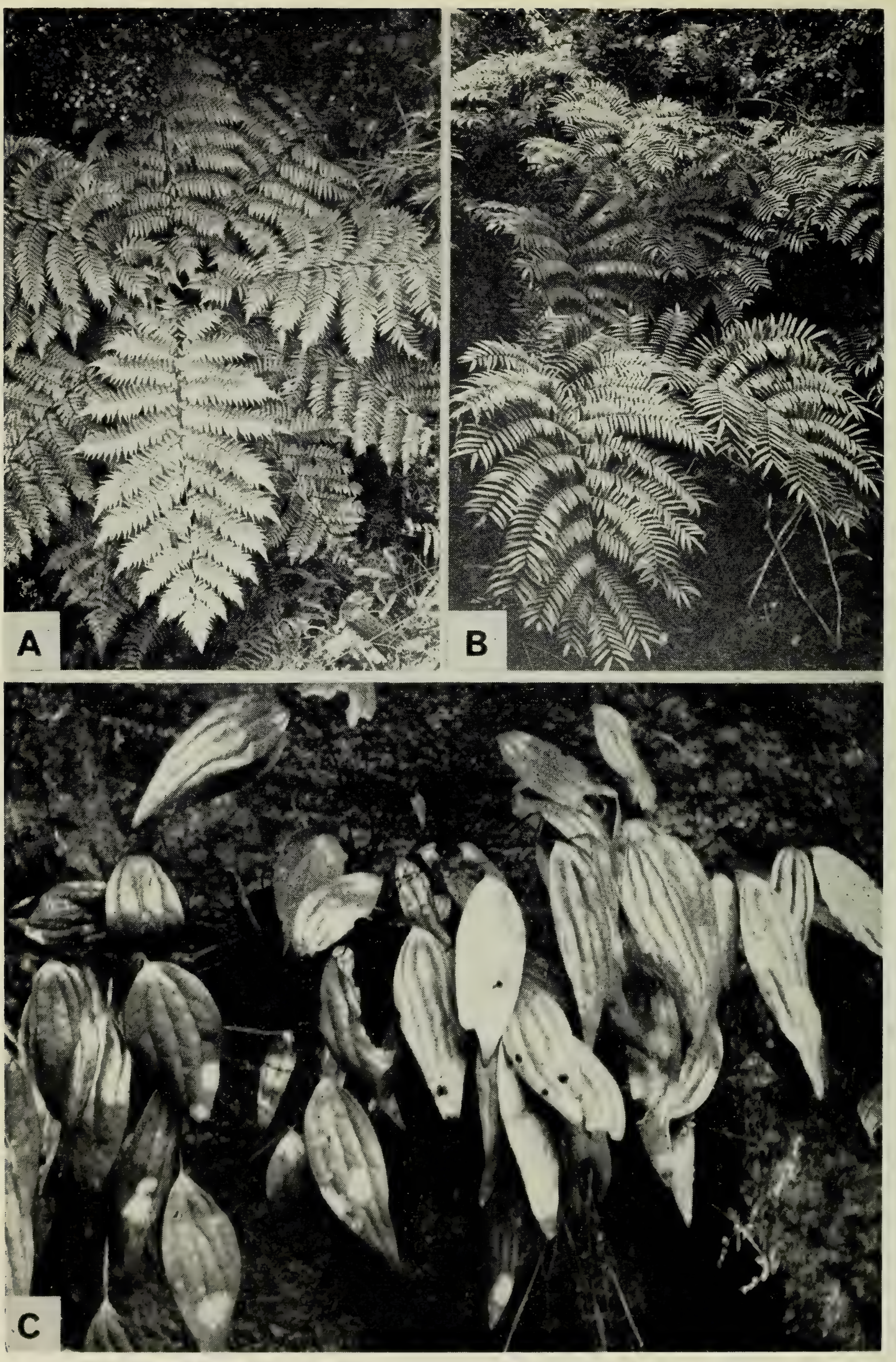

PLATE XVI—Some ferns of subtropical regions. **A:** *Cyathea fauriei*, viewed from above. Yakushima, Kagoshima prefecture, Kyushu. c. 1/40th natural size. **B:** *Angiopteris lygodiifolia*. The fronds of this hansome specimen were over 8 feet long. Yawatano, Izu peninsula, Shizuoka prefecture, Honshu. c. 1/40th natural size. **C:** *Cheiropleuria bicuspis*, Yakushima, Kagoshima prefecture, Kyushu. c. 1/5th natural size. All photographs taken by Prof. H. Takeda.

and shrubs, including evergreen oaks and species of *Cinnamomum*, with some deciduous and coniferous trees (including two species of *Podocarpus*), and an under-story of lianas, shrubs and herbs. *Camellia japonica* may be mentioned as a particularly constant indicator of the warm-temperate zone. Tall bamboos belonging to the genus *Phyllostachys* flourish in the region, and tea plants and citrus fruits are widely cultivated as is *Cryptomeria japonica*. For a more detailed description of the vegetation see TAKEDA (1913), HARA (1959) and OHWI (1965).

The broad-leaved evergreen forest, or laurisylvae, extends northwards along both the Pacific and Japan Sea coasts of Honshu to a latitude of approximately 38° N (Sendai, see FIG. 1), where the deciduous forest species become the dominant element of the woody vegetation. Areas of continental eastern Asia that correspond most closely to the warm-temperate parts of Japan are the lowland and hilly areas from southern Korea to the Yangtze valley and the mountainous regions of Chekiang, Fukien, Hunan, Szechuan, Kwangsi, Kweichow and Yunnan, and from Taiwan to the western part of Sikang and the highlands of the Himalayas, Burma and Indo-china.

It is quite impossible, in a general article of this sort, to do justice to the wealth of interesting ferns to be found in the warm-temperate area. There are too many. The following genera are widespread throughout tropical regions, and representatives of all of them are to be found in the warmer southern parts of Japan. (An asterisk indicates that the genus is represented in Japan by only a single species. With the exception of those marked † members of these genera are common and widespread in warm-temperate forests.)

*Antrophyum**†, *Ceratopteris**, *Colysis*, *Ctenitis*, *Ctenopteris**†, *Cyclosorus*, *Davallia*, *Dennstaedtia*, *Diplazium*, *Dicranopteris**, *Gleichenia*, *Hypolepis*, *Loxogramme*, *Lygodium**, *Microlepia*, *Microsorium*, *Neocheiropteris*, *Onychium**, *Pteris*, *Sphenomeris*, *Vittaria*, *Woodwardia*, *Xiphopteris**†, etc.

The familiar genera *Athyrium*, *Dryopteris*, *Polystichum*, *Lastrea* and *Asplenium* all attain a high degree of development in these regions, and some interesting species of *Lycopodium* and *Selaginella* also occur. Filmy ferns belonging to several different genera are abundant, and the genus *Diplazium* is particularly well represented, with many species which often attain a large size. Common and abundant ferns in warm-temperate forests are *Polystichum polyblepharum*, *P. tagawanum*, *Dryopteris erythrosora*, *D. varia*, *Athyrium squamigerum*, *A. vidalii*, *A. otophorum*, *Polystichopsis aristata* and *P. pseudoaristata*. The forest floor is carpeted by these plants, and also widespread are species of the genera *Coniogramme*, *Cyrtomium*, *Dennstaedtia*, *Lastrea*, *Leptogramma*, *Microlepia* and *Plagiogyria*. *Dryopteris bissetiana*, *D. lacera*, *D. uniformis*, *Athyrium iseanum* and *Pteris dispar* are much in evidence. It is an interesting fact that most of the members of the predominantly Asiatic genus *Polystichopsis* are common woodland plants in Japan, and that when they occur they do so in quantity—indeed, they are sometimes so abundant as to give a complete ground cover almost to the exclusion of everything except isolated stocks of other species. *Polystichopsis aristata* and *P. pseudoaristata* are certainly the dominant elements of the ground cover vegetation throughout the warm-temperate zone, as are *P. mutica* and *P. standishii* in the montane forests of boreal regions. It is noteworthy however, that in the warm-temperate region southwards, fern species are many in number, although the numbers of individuals of each species are not usually so many as in the case of the temperate region northwards.

Gleichenia japonica and *Dicranopteris dichotoma* are ubiquitous throughout the warmer parts of Japan, and are very common wayside ferns. Other widely distributed species frequently seen in hedgebanks and by roadsides are *Woodwardia orientalis* (whose drooping dark green fronds often attain a very large size), *Cyclosorus acuminatus*, *Lastrea oligophlebia* var. *elegans*, *L. laxa*, *L. japonica*, *Phegopteris decursive-pinnata*, *Pteris cretica*, *Onychium japonicum*, *Sphenomeris chusana* and *Osmunda japonica*. *Lygodium japonicum* is abundant in warmer areas, and it is to be seen climbing over other vegetation both in hedgebanks and in the forest.

Lepisorus onoei, *L. thunbergianus* and *Pyrrosia lingua* are very common epiphytes, the two latter even being seen on the roofs of houses, while the ubiquitous *Lemmaphyllum microphyllum*, which at first glance one hardly realises is a fern, grows everywhere on trees, rocks and walls. Two rather interesting species found on dry rocks and walls in southern districts are *Asplenium sarelii* (often with the associated *A. pekinense*) and *Cheilanthes* (*Aleuritopteris*) *argentea*, a very attractive fern with a silvery-white back to the frond. Both are often associated with base-rich rocks.

SUBTROPICAL ZONE

The influence of the warm Black Stream current is partly responsible for the incidence of a true subtropical vegetation in the extreme south of Kyushu (the Osumi peninsula), and in the islands of Yakushima and Tanegashima, which support a highly interesting fern flora. The southern part of Shikoku, the south-eastern coastal area of the Kii peninsula (Owase in Mie prefecture being a particularly good example) and the very southernmost parts of the Izu and Boso peninsulas also harbour ferns typically found much further south, and this is presumably due to the very high precipitation in these areas. Southern genera reaching their northern limits in these regions are *Angiopteris*, *Bolbitis**, *Cheiropleuria**, *Cyathea*, *Elaphoglossum*, *Histiopteris**, *Humata**, *Lindsaea* and *Nephrolepis**. (An asterisk indicates that the genus is represented by a single species in Japan.)

Noteworthy among the subtropical elements represented here are the handsome *Angiopteris lygodiifolia*, whose fronds often attain a length of over six feet, the tree-fern *Cyathea fauriei*, *Cyclosorus parasiticus* (which is rare in Japan although a very common wayside species throughout the tropics), *Plenasium banksiifolium* and *Psilotum nudum*. *Grammitis dorsipila* is a rare fern which may be found growing on mossy tree trunks in the mist zone near the summits of the higher mountains in the Ryukyu islands and south Kyushu, while a second species, *G. nipponica*, has been described from somewhat unusual habitats in the Kii peninsula and Yakushima (TAGAWA & IWATSUKI 1961). Hymenophyllaceae are of wide distribution throughout these southern regions, as are species of *Woodwardia*, *Colysis* and *Pteris*. The apogamous *P. quadriaurita* complex is particularly well-developed, and a number of segregates have been described from the warmer parts of Japan. Epiphytes are of course abundant, and two of the most attractive are *Asplenium nidus* and the closely related *A. antiquum*.

THE RYUKYU ISLANDS

The Ryukyu archipelago consists of a chain of more than one hundred small islands lying between the southern tip of Kyushu and the island of Taiwan (Formosa), being located from SW to NE within an area extending over 7° of latitude from 24° to 31° N. They may be divided into four groups: Osumi group (including the islands of Yakushima and Tanegashima); Amami group (the largest island of which is Amamioshima); Okinawa group; and Sakishima group (comprising Miyako-jima, Ishigaki-jima and Iriomote-jima etc.).

Although these islands are the peaks of submerged mountains lying on the edge of the Asiatic continental shelf, they are for the most part either flat in topography, or have low mountains below 600 m in height. Yakushima is the sole exception, for it has mountains rising to about 2,000 m. Due to the influence of the Black Stream current, the climate is warm and oceanic with a relatively high temperature (22° C at Naha on the island of Okinawa) and heavy rainfall throughout the year. The vegetation is therefore subtropical in the greater part of the archipelago and, as would be expected, the tropical elements increase in number towards the south. In this connection it may be noted that the flora of the Sakishima group is closely related to that of southern Taiwan and the Philippines.

The climate within the area changes gradually in proportion to the stituation, and as a consequence of this various tropical and subtropical genera reach their northern limits in the different island groups. The following genera extend to the southernmost Sakishima islands: *Acrostichum*, *Crepidopteris*, *Dipteris*, *Lomariopsis* and *Meringium*, while *Anapausia*, *Cephalomanes*, *Cibotium*, *Helminthostachys*, *Nesopteris*, *Schizaea*, *Tapeinidium* and *Tectaria* reach their northern limit in the Okinawa group. The genera *Arthropteris*, *Egenolfia* and *Microgonium* extend into the Amami islands, while the northern limit of *Abacopteris*, *Acrophorus*, *Callistopteris*, *Blechnum* s.s. and *Selenodesmium* is the Osumi group. From the point of view of the pteridophyte flora, therefore, the Ryukyu islands form a most interesting link between the flora of Japan proper and the tropical and subtropical regions of south-east Asia. In this connection it is interesting to note, that as far as the flowering plants are concerned, only the Osumi islands are considered to be an integral part of the Japan floral region. The flowering plant flora of this group is considered to be so close to that of Japan proper and so distinct from that of the rest of the Ryukyu archipelago that a line of demarcation has been established between the islands of Yakunshima and Amamioshima. Various authors (including KOIDZUMI 1932, MASAMUNE 1934, and NAKAI 1935) have attached great phytogeographical significance to this line. The fern flora, however, does not show such a phenomenon (ITO 1938, 1939). The close affinity between the flora of the Osumi islands and that of the rest of Japan is surely the result of the wide range of climatic zones which are to be found at different altitudinal levels in Yakushima.

YAKUSHIMA

This island is particularly interesting from a phytogeographical point of view. It is a geologically old formation, and is a southern extension of the Kyushu mountain range. Steep rocky cliffs rise from the coast, and the central peak ascends to almost 2,000 m. As a consequence of its mountainous topography subtropical, warm-temperate, temperate and boreal zones may all be recognised on the island, and within each belt many different habitats may be distinguished.

The climate is warm and moist, and the high humidity favours the development of a rich fern flora. In the lowlands below 150 m evergreen broad-leaved forests occur, and subtropical elements abound. The dominant tree species is *Castanopsis cuspidata*, and in these forests woody vines, various kinds of orchids, and large ferns are all common. Particularly notable ferns in this region are

Cyathea fauriei, *Angiopteris lygodiifolia*, *Asplenium antiquum*, *Bolbitis subcordata* and *Ophioderma pendulum.* Warm-temperate forests occur up to about 1,000 m and most of the fern genera of this region have already been listed as occurring in the warm–temperate parts of Japan proper. Temperate plants common in Japan occur in the middle and upper parts of the island, and some species, notably the three mentioned below, have their southernmost limit of distribution here. The uppermost part of Yakushima is covered by the *Pseudosasa owatarii* association and in this zone *Polystichopsis mutica* and the alpine *Lycopodium sitchense* var. *nikoense* occur. In contrast, *Plagiogyria matsumureana*, a common fern of montane regions throughout Japan, occurs at rather low elevations (500 – 1,000 m) on the island.

Yakushima is thus a meeting-place for southern elements extending northwards and boreal and montane elements extending southwards. It is generally thought that the temperate elements migrated southwards into the island during the Ice Age, and that they have been isolated from their allies for a very long time. In contrast, many of the subtropical elements are considered to have spread from the south in comparatively recent times.

COMPARISON WITH BRITAIN

There are some 65 species of Pteridophyta native to the British Isles. With the exception of *Anogramma*, *Ceterach* and *Pilularia*, all the British genera are represented in Japan. Indeed, 57% of the species are the same, and as mentioned above, they comprise for the most part members of circumpolar genera of wide distribution, such as *Lycopodium*, *Botrychium* and *Woodsia. Isoetes* is represented in Japan, although the species are different. With the sole exception of *E. telmateia*, all British species of *Equisetum* may be found in Japan, where they occur mostly in Hokkaido and northern Honshu. *E. arvense*, as in England, is a very common plant of waysides and waste ground.

The adder's tongue, *Ophioglossum vulgatum*, occurs throughout the Japanese archipelago, as would be expected from its wide distribution in the temperate areas of the northern hemisphere. Other species are also found, and particularly interesting is *Ophioderma pendulum*, a tropical species found in the island of Yakushima. There are five species of Osmundaceae in Japan, *Osmunda japonica* being very common throughout both temperate and warm-temperate regions. *Osmundastrum cinnamomeum* var. *fokiense* has a north-east Asian distribution extending as a species to eastern North America, and in central Honshu it often appears as one of the first colonisers after the felling of forest. Hymenophyllaceae are abundant in Japan, especially in warm-temperate and subtropical regions, and six genera are recognised (COPELAND 1947). The cosmopolitan species *Adiantum capillus-veneris* and *Cystopteris fragilis* also occur here, although the former is very rare. *C. fragilis* is found on mountains in colder regions, where usually only a few plants may be observed in rock crevices. Although it has on occasion been found in abundance on walls in mountain villages, it can hardly be described as a common species. Two other ferns with which European botanists will be familiar are *Onoclea sensibilis* and *Lastrea thelypteris* (= *Thelypteris palustris*). Both occur in similar habitats in Japan—in wet patches in woodland or on marshy ground at low elevations.

Athyrium, *Dryopteris* and *Polystichum* are all widespread genera in Japan, and each comprises a multiplicity of species extending from alpine to warm-temperate and subtropical regions. Species-complexes occur within each genus, and there is surely enough material here to keep taxonomists and cytologists busy for many years to come! In Japan alone there are at least forty distinct species of *Athyrium s.l.*, most of these being Asian taxa also occurring in China, Korea and Taiwan. Some, for example *A. atkinsonii*, extend as far as the Himalayas. Two-thirds of the species occur in the warm-temperate zone, some being restricted to subtropical parts of Yakushima. The rest comprise species of northern affinity, including three endemics. *A. vidalii*, *A. pycnosorum*, *A. niponicum*, *A. yokoscense* and *A. otophorum* are all common and extremely variable, and many associated taxa have been described.

The *Dryopteris* species occurring in Japan are very different from those of Europe, although the common *D. crassirhizoma* and its relatives are morphologically similar to *D. filix-mas*. As with *Athyrium*, the majority of the taxa show affinity either with those of mainland Asia or Taiwan, and many occur in warm-temperate regions. Some species show a relict distribution, for example, *D. amurensis* and *D. gymnophylla*. Two apogamous species, *D. erythrosora* and *D. varia*, are widespread and extremely variable, and many segregates have been given names. Whether all the taxa described are in fact distinct entities, however, is somewhat questionable. The *D. atrata—dickinsii—commixta* group also appears to be a species-complex.

Polystichum in Japan is particularly interesting. Within the bipinnate species (Section Metapolystichum) there are at least two complexes, one group of species centred upon *P. retrosopaleaceum*, and the other upon *P. polyblepharum*. In many cases there are diploids and associated tetraploids, and it is tempting to suggest an autopolyploid origin for several such species. However, the situation is certainly not so simple, and many different factors have probably played their part in the evolution of the genus. Much experimental work is necessary before even preliminary relationships can be worked out. It is interesting to note that, as in Europe, hybridisation is rife, and already some 22 hybrid taxa have been recognised (KURATA 1964). Slightly less than half of the Japanese species are endemic; some species are of northern and circumboreal affinity (e.g. *P. braunii*), some are southern and some are related to Chinese taxa. An interesting group is that comprising the apogamous species *P. tsus-simense*, *P. neolobatum* and *P. rigens*. In addition to the bipinnate section of the genus, nine simply pinnate taxa also occur in Japan. Many of these are of rare occurrence in high mountains, and they appear to be very distinct, both from each other, and from the section Metapolystichum (TAGAWA 1940).

The genus *Asplenium* is well represented in Japan, and some familiar European species can be found as well as a wealth of different forms in the warm-temperate and sub-tropical parts of these islands. Some species are apogamous, for example *A. unilaterale*. A few hybrids have been described, notably *A.* × *shikokianum*, but for the most part the species are very distinct, often being both ecologically as well as geographically separated. The *Asplenium trichomanes* complex is represented in Japan where, in the southern parts of the country, a robust (and incidentally, sometimes proliferous) form is commonly found on the dry stone walls bordering paddy fields. A possibly related species, *A. tripteropus*, occurs in mountains throughout the warm-temperate zone. The exact identity of Japanese material and its relationship to the complex as represented in other parts of the northern hemisphere is at present under active investigation (LOVIS & SLEEP, in preparation). *Camptosorus* is another interesting genus which is also present in America although not in Europe. It is usually found on base-rich rocks (although not restricted to them) and it hybridises with several species of *Asplenium* (KURATA, pers. comm.). A particularly notable hybrid is the rare *A.* × *kobayashii*, which is a putative cross between *Camptosorus sibiricus* and the common *A. incisum*. Our familiar *Phyllitis scolopendrium* is also present in Japan where, like *Camptosorus*, it is often, although not always, found on base-rich soils. It is usually found in woods, and can sometimes be observed in great abundance in the deciduous forests of the temperate region. Although theoretically possible, no hybrids involving this species have as yet been found.

Polypodium is another particularly interesting genus, for it comprises two endemic species, *P. fauriei* and the rare and highly individual *P. someyae*, two taxa of southern distribution and affinity, *P. niponicum* and *P. formosanum* (possibly related to similar forms occurring in Taiwan, according to TAGAWA 1954), the American *P. virginianum*, and *P. vulgare*. *P. fauriei* is a diploid species which, although not common, is widely distributed as an epiphyte in temperate forests. It is easily recognised by the fact that, on drying, it curls up like a watch-spring. The relationship (if any) of both this species and the Japanese *P. vulgare* to the European complex is an interesting question and is another subject under investigation. Although widespread in woods in Europe, *P. vulgare* is very rare in Japan (sometimes locally abundant), where it has a scattered north-western distribution, often being found on rocks in exposed places close to the sea.

As has already been noted, the pteridophyte flora of Japan shows most resemblance to that of mainland China. The number of endemic species is rather small, and amounts to only 24% of this section of the flora. Particularly interesting endemic ferns are the two species of *Hypodematium*, also *Monachosorum flagellare*, *M. arakii* and *Ptilopteris maximowicziana*. In Japan, endemism at the species level is said to be well developed (MAEKAWA 1953) in the Fuji volcanic range and in the region of the Fossa Magna (see FIG. 1). These areas were subject to a long period of volcanic activity during the Tertiary period, when they became pioneer areas for the development of new taxa. It may be purely coincidence that several endemic ferns are to be found in this region. One of the most interesting is *Polystichum ohmurae*, a diploid species (SLEEP, unpublished) which shows a superficial resemblance to *P. braunii*, although possessing very characteristic marginal sori. It is interesting to speculate that the prolonged volcanic activity in this region may have had some influence on some of the circumpolar species, elsewhere widespread, which now show a very restricted distribution in this part of Japan, for example, *P. lonchitis*.

The incidence of apogamy is higher in the Japanese fern flora than it is in Britain, and is widespread in the following genera: *Pteris*, *Cyrtomium*, *Dryopteris* and *Diplazium*. Some species of *Athyrium*, *Asplenium* and *Polystichum* are also apogamous.

The pteridophyte flora of Japan is thus not only exceedingly rich and diverse, but it presents a vast selection of interesting material for the taxonomist and experimental worker. In conclusion I should like to pay tribute to all those Japanese botanists who in their various ways are contributing to an understanding of this ancient and fascinating group of plants. A great deal of taxonomic work is carried out in Japan both on the native flora and on the ferns of the whole of south-east Asia. The most important centres in this respect are Kyoto University (Professor M. Tagawa and Dr K. Iwatsuki), Tokyo University (Professor S. Kurata) and Tokyo University of Education (Professor H. Ito). The bulk of the pioneer descriptive work on the fern flora of Japan and Taiwan can be attributed to the labours of Professors Ito and Tagawa and indeed, it was these two indefatigable botanists who laid the foundations for the study of pteridology in Japan. Work is also active in other fields. The late Professor S. Momose devoted his life to a monumental study of the prothallium of various ferns, and now a new and young generation of pteridologists is turning its attention to the cytological field, very successfully, for the chromosome numbers of some 300 Japanese fern species have been recorded to date. Mention must also be made here of the ambitious cytological programme which is carried out at Hiroshima University under the direction of Professor S. Tatuno, the aim of which is an evolutionary study of the phylogeny of the Pteridophyta using karyotype analysis.

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NOTES AND NEWS

POLYSTICHUM SETIFERUM 'Plumoso-diversilobum Baldwinii'

Polystichum aculeatum and *P. setiferum* have given us a wealth of the very fine garden plants, although to our knowledge very few of the best are still in existence. Among the varieties of these species we must number one exceptional plant, *P. setiferum* 'Plumoso-divisilobum Baldwinii'. About 1875 Jones and Fox, two outstanding breeders, raised several extraordinary plants from a '*decompositum*' bred from a wild find of the same varietal type, all of them finely and elaborately divided forms and a big advance on and unlike anything hitherto known. They were named "*plumoso-divisilobes*", and some of them are still in cultivation, notably the well-known *P. setiferum* 'Plumoso-divisilobum Densum', and other larger-growing ones. These are all robust plants, but among them was 'Baldwinii' which stood out as the "finest cut and unique". In 1914 (*Gazette*, Vol. 2 No. 21) we find W. B. Cranfield, after trying in vain to trace the variety, lamenting its loss and referring to the only relic left—a frond in the possession of C. T. Druery. The one illustration in print which I have been able to find is a photograph in the *Gazette* in 1917, (Vol. 3 No. 34), and it was therefore with the greatest delight that I recently found a dried frond among some of Druery's papers labelled "Baldwinii original", which must no doubt be the one referred to by Cranfield in 1914. This frond, now in my herbarium, is 18 inches long by 4 inches wide, divided in the usual "*plumoso-divisilobum*" manner with long overlapping twice-divided pinnules. The final segments are so fine and delicate that other plants of this variation look coarse and heavy alongside it.

The importance of this find lies in the fact that none of its descriptions adequately describe the delicacy of this fern, and this also applies to the photograph which depicts it more like the ordinary run of *plumoso-divisilobes*. The frond in my possession is so much finer that I wonder if the photograph is correctly named, although of course, it is possible it may have suffered in the reproduction processes. The fact remains, however, that it appears in the *Gazette* in 1917, three years after Cranfield recorded that the only frond known to exist was in Druery's possession, and remained with his papers after his death. With both in front of me as I write, it is very obvious that the photograph was not taken from this frond and I am pleased to have a specimen to which to attach the name.

J. W. DYCE

OPHIOGLOSSUM VULGATUM subsp. AMBIGUUM in Teesdale

Ophioglossum vulgatum L. subsp. *ambigum* (Coss. & Germ.) E. F. Warb, was found by Nature Conservancy staff in 1968, in the course of a survey of meadows and pastures in the Proposed Teesdale National Nature Reserve. According to the *Flora of the British Isles* (CLAPHAM, TUTIN & WARBURG Ed 2, 1962) this plant has not until now been recorded from the North of England or away from the sea. It was locally frequent in the rush zone of a wet pasture just outside an area of birch/alder woodland at about 1000 feet above sea level on a moderate slope. Cores taken with a soil probe showed a varying thickness of brown forest soil overlying up to a foot of clay. It was growing among *Athyrium filix-femina*, *Dryopteris austriaca*, *Equisetum palustre* with spermatophytes and bryophytes typical of this habitat.

C. J. HADLEY

SPECIES OF *PTERIS* COMMONLY IN CULTIVATION

T. G. WALKER*

INTRODUCTION

The vogue—one might almost say mania—for fern-growing which reached its height in Victorian and Edwardian times as a pursuit comparable in scale only to the present day interest in house plants, has suffered a considerable decline in recent years. Indeed, a browse through the copiously illustrated 8-volume work, *Ferns: British and Exotic* by E. J. Lowe, published in 1858, quickly drives home the fact of how many excellent species once commonly in cultivation and available from a relatively large number of commercial growers are now only to be found in the national botanic gardens or in the living collections of a few universities.

However, one exotic genus of ferns that has survived the change in fashion rather better than most is *Pteris* and a few species are freely available in shops and garden centres at the present time as well as from specialised nurseries. This genus has been the subject of my researches on fern evolution for a number of years and it was suggested to me that some general notes on species which are either still fairly widely cultivated or which are still available but deserve to be better known might be of interest to the readers of the *Gazette*. I have constructed a key which should enable these species to be identified fairly easily. It should be pointed out that the key is only intended for this limited use and it would certainly be quite inadequate if tried on all the species of *Pteris* known. I have not included cristate and similar abnormal forms which are almost entirely confined to *P. cretica*. These will form the subject of a later paper by H. J. Bruty and J. A. Crabbe.

KEY TO THE COMMONLY CULTIVATED SPECIES OF *PTERIS*

1. Fronds once pinnate or with only a few strap-like branches to pinnae:
  2. Pinnae more than 10 pairs, always simple .. 2. *vittata*
  2. Pinnae less than 10 pairs, often branched:
    3. Pinnae decurrent in at least top half of frond 3. *multifida*
    3. Pinnae not decurrent (or only terminal one):
      4. Fertile pinnae 5 mm or more wide:
        5. Pinnae green throughout .. .. 1. *cretica*
        5. Pinnae with white central streak .. 1a. *cretica* var. *albo-lineata*
      4. Fertile pinnae 4 mm or less wide:
        6. Pinnae green throughout .. .. 4. *ensiformis*
        6. Pinnae with white central streak .. 4a. *ensiformis* var. *victoriae*
1. Fronds compoundly pinnate:
  7. Fronds tripartite .. .. 10. *tripartita*
  7. Fronds not tripartite:
    8. Pinnae entire on upper margin, pinnatisect on lower margin .. .. 5. *semipinnata*

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8. Pinnae pinnatisect on both margins:
  9. Lowest pair of pinnae with several branches (compound pinnules) on lower side .. 11. *tremula*
  9. Lowest pair of pinnae with single branch on lower side:
    10 Veins united to form costal arch .. 6. *biaurita*
    10. Veins all free:
      11. Pinnae with broad white central streak .. .. 7. *argyraea*
      11. Pinnae green:
        12. Costae and costal spinules red .. .. 8. *aspericaulis*
        12. Costae and costal spinules not red .. .. .. 9. "*quadriaurita*"

NOTES ON THE SPECIES

1 *Pteris cretica* L. FIG. 7

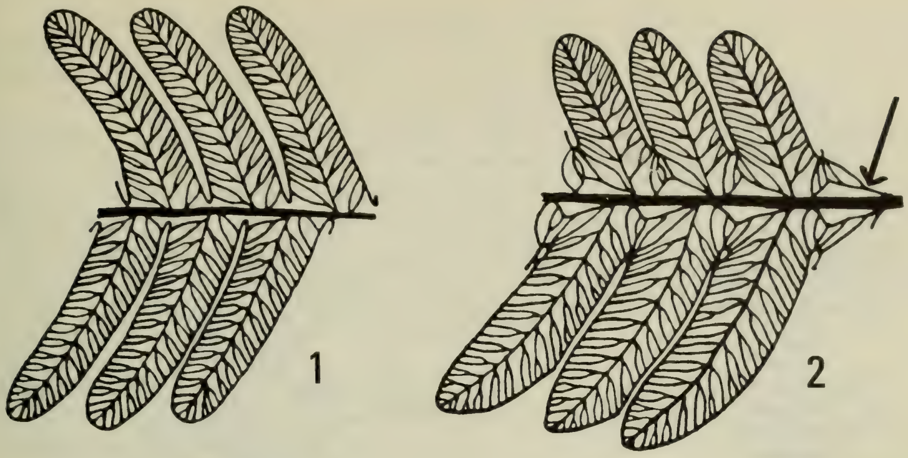
This species occurs in the wild virtually throughout the whole range of the genus and in Europe is found in the Mediterranean region. This is one of the most popular of the exotic ferns still widely sold in Britain today. According to LOWE (1858) the exact date of its introduction into this country is not known but it was cultivated at Kew in 1822 and had a rapid success. One printed comment on a herbarium sheet at the British Museum (Natural History) reads "Though not a British fern, it is abundant in London, where it is a common object of the street barrow and the lodging house parlour" and if one substitutes garden centres and florists for the street barrow, and the private house for the lodging house parlour, this statement is as true today as when it was first written. Probably one of the principal reasons for its success is that *P. cretica* is tougher than most ferns and can survive the drier atmosphere and variable temperatures of the average living room, not to mention the periodic neglect to which most house plants sooner or later fall victim. This general toughness has enabled the plant to establish itself for short periods of time as escapes in Britain in sheltered and protected places such as the old brickwork of walls (KENT 1963) and in the grating of cellars (PALMER 1965).

Numerous sports and "varieties" have arisen, many of which have been given names. Such "varieties" breed true to type normally because the species is apomictic in its reproduction, thus eliminating genetic segregation.

Pteris is unique among the ferns in possessing several species with variegated forms and *P. cretica* is numbered among them. Variety *albo-lineata* has a broad white streak down the middle of the pinnae and was introduced into England in 1860 from the world-famous Botanic Gardens at Buitenzorg (Bogor) in Java (LOWE 1868) where it is still cultivated. BRITTEN (1881–1882) commented that this variety "is deservedly in request for bouquets, as it retains its freshness for a long time". This use of the plant, which was obviously common in the past, unfortunately seems to have died out in more recent times.

2 *P. vittata* aggregate. FIG. 3

It is convenient to consider the two species *P. longifolia* L. and *P. vittata* L. together as they are virtually identical in appearance except for relatively small differences in the shape of the base of the pinnae. The Old World forms are



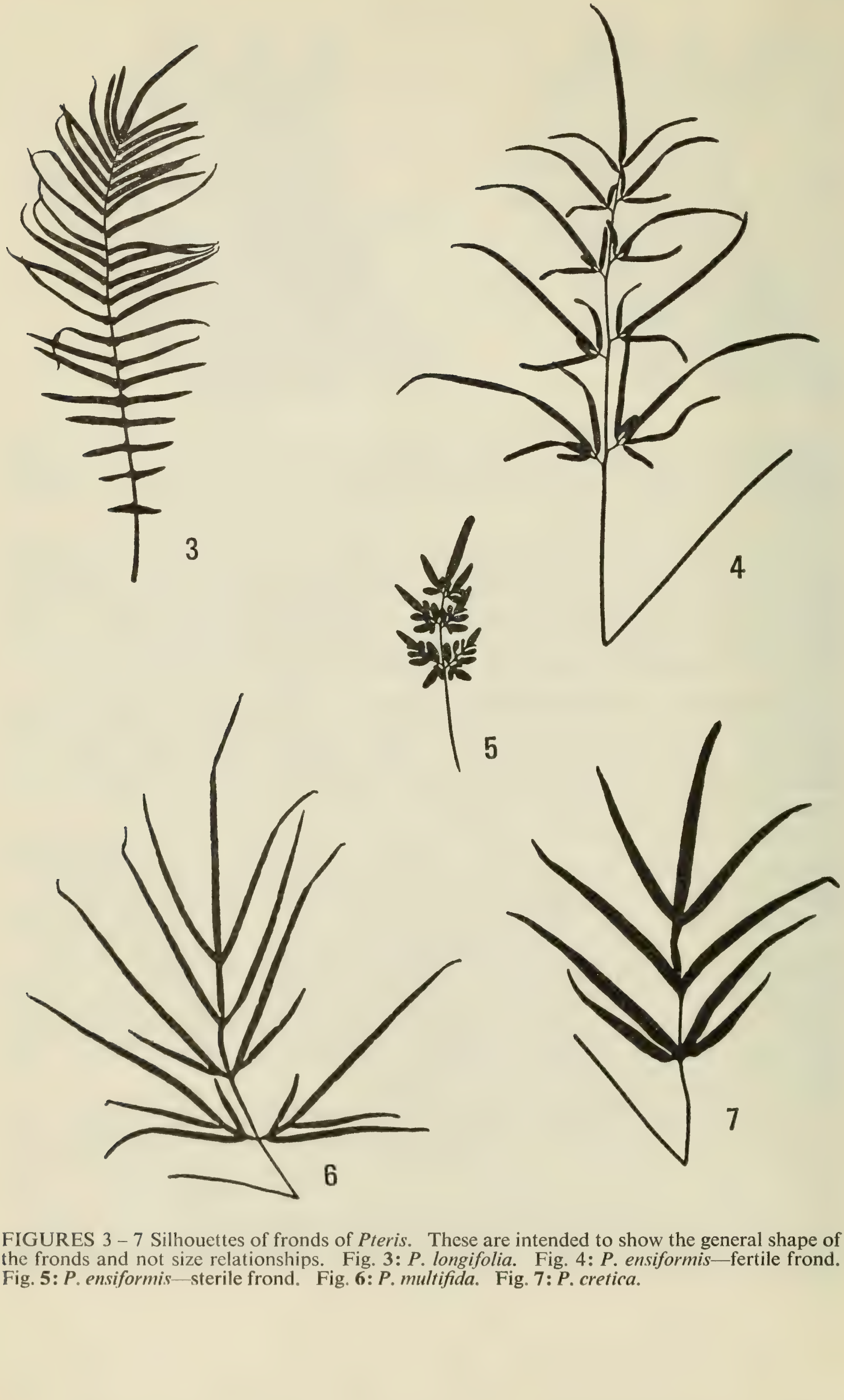
FIGURES 1 & 2 Venation patterns. Fig. **1**: Free veins—as in *P.* "*quadriaurita*", *P. argyraea*, etc. Fig. **2**: Veins united near midrib or costa of pinna to form a costal arch (arrowed) as in *P. biaurita.*

considered to be *P. vittata*, those from the New World *P. longifolia;* most cultivated plants are *P. vittata* (see JARRETT 1968). The former occurs in the Mediterranean region of Europe and extends eastwards right through to the Pacific. As one might expect in such widespread species there are local geographical variants, some of which have been given specific names and others treated as varieties.

P. longifolia was introduced into England in 1770 (LOWE 1858) and BRITTEN (1881–1882) adds the further information that it was introduced from the West Indies by a Mr James Gordon (AITON 1789). From its West Indian origin it is evident that *P. longifolia* was the first introduction, the date of introduction of *P. vittata* is unknown, but presumably later.

P. vittata is very easily grown from spores which are exceedingly beautiful objects as seen under the microscope. The prothalli reach maturity rapidly and must be watered on the surface to effect fertilization since this is a sexual species. The sporelings also are produced rapidly and indeed can become somehwat of a pest in a tropical greenhouse, growing in any nook or cranny. When fully grown the plant is not fussy about conditions, thriving equally well in a humid or a dry atmosphere. In appearance it is a handsome plant with its numerous simple pinnae, looking at first glance not unlike *Nephrolepis*—the Ladder or Boston fern. The silvery white scales which densely cover the shortly creeping rhizome and stipes contribute to the general attractiveness.

P. vittata has occasionally been reported as a sporadic escape from cultivation in Britain but in nearly every case it has not survived more than a winter. However, a large colony has become established in the Forest of Dean and is still spreading since the first report of its discovery (LOUSLEY 1964). Here the habitat has a tropical microclimate produced locally by the internal combustion of a slagheap which raises the temperature to such an extent that it is hot underfoot (see HOLLAND 1968).



FIGURES 3 – 7 Silhouettes of fronds of *Pteris*. These are intended to show the general shape of the fronds and not size relationships. Fig. **3:** *P. longifolia*. Fig. 4: *P. ensiformis*—fertile frond. Fig. **5:** *P. ensiformis*—sterile frond. Fig. **6:** *P. multifida*. Fig. **7:** *P. cretica*.

3 *P. multifida* Poir. FIG. 6

This species is figured in LOWE (1858) under the name of *P. serrulata.* It comes from the Eastern Hemisphere, being common in parts of Japan, China etc. and has been widely grown in this country since its introduction in 1770.

P. multifida tolerates a wide range of temperature and stands up well to a fair degree of neglect. Lowe comments that "young plants from spores spring up . . . so as to constitute itself a troublesome, yet pretty exotic weed". For this reason one should avoid sowing spores of it when those of other species are also being sown. *P. multifida* spores will contaminate the pots and because of the speed at which they germinate and produce vigorous sporelings will overwhelm any less robust species. However, despite this cautionary note, *P. multifida* is well worth growing for its graceful foliage and its trouble-free cultivation and it is one of the commonest exotics on sale.

4 *P. ensiformis* Burm. fil. FIGS 4 & 5

This species again is Eastern Hemisphere in origin, ranging from the Indo-Malayan region to the Pacific.

The fronds are dimorphic or subdimorphic, with the fertile fronds being longer than the sterile and with narrower pinnae. This habit gives the plant a pleasing effect, with short sterile fronds tending to hide the bare stipes of the fertile ones. LOWE (1858) illustrates this plant under the name of *P. crenata* but his picture is not typical and fails to do justice to the plant. He notes that it was in cultivation at Kew in 1822 and comments that it was not a common species. This is rather surprising because it thrives with ordinary care as a stove plant, is easily raised from spores and makes an attractive plant, although not as spectacular as its variegated variety *victoriae*.

4a *P. ensiformis* var. *victoriae* Baker

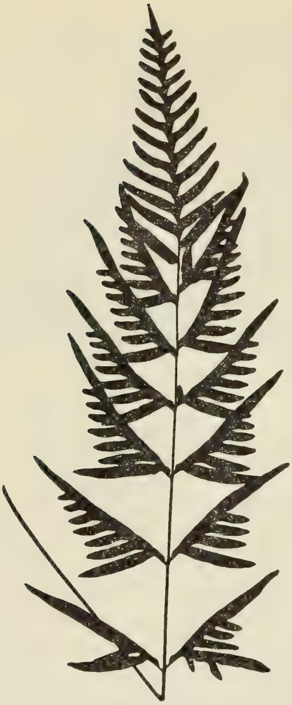
This was first described by BAKER (1890) who stated that it had been recently imported by Mr William Bull from the Eastern Archipelago. This again is probably yet another variegated plant for which we are indebted to Java. The variety is identical with the type species except for a very prominent silvery white streak along the pinnae which makes it one of the loveliest of ferns. This variegation is due to a dominant gene and on crossing with the normal green type all the F_1 progeny are variegated. The ease of cultivation and its beauty combine to make it an ideal plant for hot-houses and it deserves to be much more widely grown than it is at present.

5 *P. semipinnata* L. FIG. 8

This species ranges from Japan to Malaysia and was more commonly found in cultivation in the last century than now as is shown by Lowe's list of suppliers of plants.

Like the previous species it is easy to grow in a heated greenhouse and deserves to be better known. It makes a nice compact plant and the fronds are very striking—the pinnae having the unusual feature of being deeply dissected on the lower margin and straight on the upper. The stipes also are decorative, being a polished chestnut in colour.

A much smaller form of this exists called either *P. semipinnata* var. *dispar* (Kze.) Baker or *P. dispar* Kze., but I have found it is in no way as amenable to cultivation as the type.



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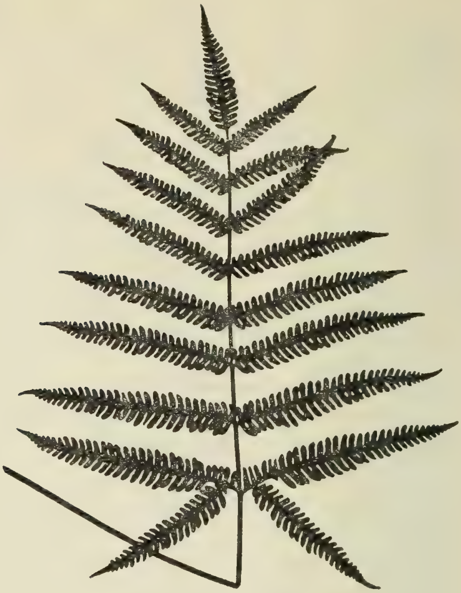

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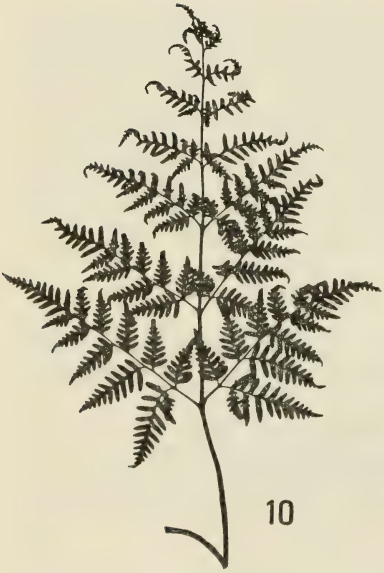

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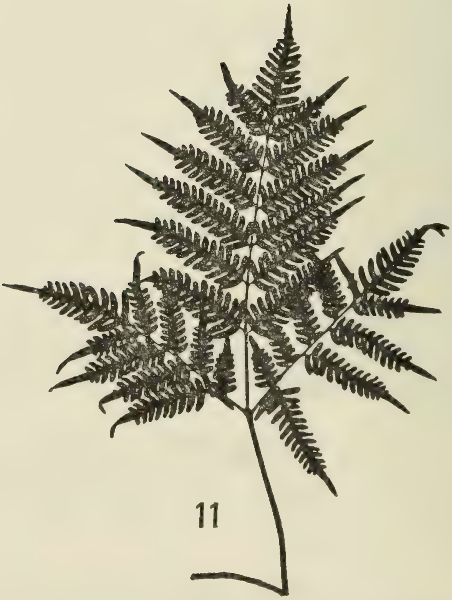

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FIGURES 8 – 11 Silhouettes of fronds of *Pteris*. These are intended to show the general shape of the fronds and not size relationships. Fig. **8:** *P. semipinnata*. Fig. **9:** *P.* "*quadriaurita*" type —similar habit also seen in *P. argyraea*, *P. biaurita* and *P. aspericaulis*. Fig. **10:** *P. tremula*. **Fig. 11:** *P. tripartita*.

6 *P. biaurita* L.

This plant, like all the others to follow, is fully pinnatifid but is easily distinguished by the fact that the lowest veins fuse together to form a single arch on either side of the midribs of the pinnae (see FIG. 2).

This "species" is really a complex of apomictic forms which extends throughout the tropics. There are several different chromosomal races and details of the morphology and juvenile fronds vary according to the plant's origin—a feature in many apomictic ferns. Linnaeus first described *P. biaurita* from West Indian material. It was introduced to Kew in 1842 by William Purdie who was sent to Jamaica by W. J. Hooker as a plant collector and who later became Superintendent of the Botanic Garden at Trinidad.

P. biaurita ultimately makes a much larger plant than the others described above, producing fronds up to 5 feet in length as compared with only one or two feet for *P. cretica*, *P. semipinnata*, etc. Like many of the *Pteris* species which have large fronds and erect rhizomes the rootstock tends to outgrow its strength and flop over and eventually snap off under the weight of foliage unless this is prevented either by frequent repotting or by staking.

7 *P. argyraea* Moore

This is another large species, comparable in size with *P. biaurita*, but has free veins and a prominent silver-white band down the centre of the pinnae making it one of the most spectacular of all ferns.

It was described by THOMAS MOORE in 1859 as having been introduced by Messrs Veitch & Son from Central India and its horticultural value was immediately recognised by the award of a First Class Certificate of Merit from the Royal Horticultural Society. The exact origin of this plant is in some doubt, despite Moore's statement and it also occurs in Ceylon and Java. The plants at present in cultivation may well in fact have come from Java—the Ceylon form being very difficult to keep growing as I have found by experience, although it makes very vigorous and long-lived hybrids when crossed with other species. Further, the plants commonly in cultivation now have the appearance of the more robust Javan form rather than that of the Ceylon plant.

8 *P. aspericaulis* Wallich

This species was described by the famous botanist Dr Wallich from Indian material and many collections of it have since been made from the Himalayan region.

The plant is much smaller than the other compoundly pinnate species mentioned in this article but is of great horticultural value because of its colouring. The stipe, rhachis and costa are all deep red and conspicuous small red spines are present on the costae and veins. In addition, the young fronds are red throughout. These features make it a useful foil for some of the variegated varieties. The species is apomictic, although there are other closely related species in the complex which are sexual such as *P. roseo-lilacina* Hieron.

One of the great losses to horticulture has been the complete disappearance as far as I am aware of the plant figured by LOWE (1868) under the name of *P. aspericaulis* var. *tricolor* Moore. This combines the virtues of colour of *P. argyraea* and *P. aspericaulis*, having red rhachis, costa, etc. and red young fronds in combination with the white streak to the pinnae. This plant was obviously highly prized for its decorative value as Lowe quotes several nurseries which a century ago sold it at two guineas each—a considerable sum of money at present day values and the subsequent loss is all the more surprising.

9 *"P. quadriaurita"* FIG. 9

This "species" presents a real problem in any discussion because the name *P. quadriaurita* has been applied indiscriminately over the years to what are in fact several dozen different species.

The true *P. quadriaurita*, that described initially by Retzius, is quite distinctive and is very limited in its distribution, occurring in the Nilgiri Hills of India and in Ceylon. It is very rare in cultivation, the specimens in my collection at Newcastle probably being the only ones in Europe. However, many different species are in cultivation under this name and have such similar general morphology that they can be included in the key for identification purposes provided that it is realised that this name tends to hide what might be termed a taxonomic rag-bag.

Most of the species grown are vigorous and decorative, especially when intermixed with some of the variegated and the simply pinnate forms.

10 *P. tripartita* Sw. FIG. 11

P. tripartita is widely distributed in the tropics of the Old World and is the commonest member of a complex of several closely allied and similar looking species.

This plant may be found in most large collections of tropical ferns in botanic gardens although it is unsuited to the small greenhouse because of its large size. The stipes alone are often 5 feet high and these are surmounted by huge fronds which, as the name suggests, are divided into three major branches before being repeatedly subdivided. However,where space is available it is well worth growing as it can be used to make a striking centre-piece around which the smaller species can be grouped. It also has the great advantage that it reaches full size in a relatively short time (2 or 3 years) unlike the slower growing tree-ferns. The spores readily germinate and sporelings are produced in only a few weeks from sowing.

11 *P. tremula* R. Br. FIG. 10

This together with *P. cretica*, is one of the commonest exotic ferns grown in this country and is freely available commercially, being stocked by many small retail florists. It is a native of Australia, New Zealand and Tasmania and is quite tough, standing up to shop and household conditions reasonably well, although never attaining its full beauty under these circumstances. It thrives in shady, damp and frost-free conditions and is an ideal subject for the grottoes, once so popular in large houses but now, unfortunately, becoming rare. Excellent specimens of this fern growing under ideal conditions may be seen in one of the greenhouses in Tatton Park in Cheshire.

P. tremula is one of the easiest ferns to cultivate—so easy in fact that it has to be treated with a certain amount of caution and I can do no better than to quote LOWE's (1858) comment "This abundant species, handsome as it is, becomes a pest in our collections; young plants spring up in all the pots, and increase so rapidly in size, that unless they are destroyed would soon monopolize a whole house to themselves. No ferns grow so freely from spores as *Pteris tremula*, . . .".

CULTIVATION

In an article of this nature it has only been possible to deal with those species of *Pteris* which are most likely to be found in cultivation on a fairly extensive scale. The genus is a large one and there are many more species which deserve to be more widely known but which are either very difficult to obtain or tricky to cultivate unless hot, humid conditions are supplied. Nearly all the species mentioned above require plenty of moisture but like so many ferns will not tolerate water standing round their roots. Hence the first essential ingredient for success is to water only as required and not to over-water. Good drainage is necessary and an open potting mixture containing plenty of coarse peat together with plenty of crocks in the bottom of the pot is ideal. A further hint for successful cultivation is that many ferns do not thrive in plastic plant pots and clays should always be used. The fern roots appear to need the aeration provided by the porous clay pot and we have found that plastic pots also suffer from the disadvantage that if the soil is accidentally allowed to dry out it contracts from the side of the pot and makes rewetting difficult.

The sporelings represent the most vulnerable stage to drying out whilst still in thumb pots and we guard against this by plunging the pots in a coarse mixture of peat and either small gravel or well-washed coke breeze which is kept moist. This prevents excessive evaporation from the sides of the pots whilst still allowing adequate aeration. A moist atmosphere and shade from direct sunlight is also essential in most cases.

Ideally ferns should be repotted frequently, but this is not always possible and weekly or fortnightly applications of a patent liquid plant feed is very beneficial during the growing season. A few of the species mentioned above such as *P. cretica* will survive a fair degree of starvation and neglect but these are the exceptions rather than the rule and all repay routine attention handsomely.

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NOTES AND NEWS

NAMES OF HYBRIDS IN THE *POLYPODIUM VULGARE* COMPLEX

During the course of preparing an account of the three hybrids formed between the members of the *Polypodium* complex in the British Isles* it was realised that the present nomenclature proposed by Rothmaler [in Rothmaler, W. & Schneider, U. *Die Kulturpfl. Deutsch. Akad. wissen. Berlin*, Beiheft 3: 234–248 (1962)] did not conform to the *International Code* (1966). The following amendments are therefore proposed.

Polypodium* × *rothmaleri Shivas **nom.nov.** (=*P. australe* Fée × *P. interjectum* Shivas)

Syn: *P.* ×*shivasiae* Rothm., *loc. cit.*: 245 pro *P. australe* × *vulgare* subsp. *prionodes* Rothm. Rothmaler had previously proposed a name at specific rank for *P. australe* × *vulgare* subsp. *vulgare* (see below) and therefore × *shivasiae* is superfluous whilst *P. interjectum* is regarded as a subspecies of *vulgare*.

Polypodium* × *mantoniae (Rothm.) Shivas **comb.nov.** (=*P. interjectum* Shivas × *P. vulgare* L.) Bas: *P.* ×*mantoniae* Rothm., *loc. cit.*: 246 pro *P. vulgare* subsp. *prionodes* × *vulgare* subsp. *vulgare*. Syn: *P. vulgare* subsp. hybrid *mantoniae* (Rothm.) Schidlay. (in Fl. Slov. 2: 225, 1966).

Polypodium* × *font-queri Rothm. in Cadivall-Font-Quer, *Fl. Catalunya* 6:353 (1936). (=*P. australe* Fée × *P. vulgare* L.).

M. G. SHIVAS
MRS. T. G. WALKER

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*For *Hybridization in the British Flora* edited by C. A. Stace.

A FERN FOR THE AQUARIUM AND TERRARIUM

An interesting paper by G. Benl, H. Heine & P. Michel, Une fougère d'Afrique tropicale pour l'aquarium et le terrarium: *Bolbitis heudelotii* (Bory ex Fée) Alston in *La Pisciculture Francaise* no. 20: IV–XI (1969, fourth quarter) describes the results of several aquarists who have grown this fern, both submerged and in closed cases where the humidity is 100%. As one might expect, the submerged plants do not produce fertile leaves and rarely bud from the leaf-tips as does the fern in its native habitats—in wet shady gullies or associated with the spray from waterfalls. Optimum aquarium conditions appear to be in well circulated water of pH just under 7 and a temperature of 24–26°C; a substrate of porous lava blocks allows aeration of the roots and rhizome and at the same time offers a good anchorage.

A. C. JERMY

THE SYNTHESIS OF A NEW *ASPLENIUM*

J. D. LOVIS*

Three years ago, it was recorded in the *Gazette* (1967, **9**: 361), that *Asplenium adulterinum* had been successfully synthesised. At that time, a fuller report was promised. Since then, a brief account of this synthesis has been published elsewhere (LOVIS 1968). It now seems more appropriate to describe here the synthesis of an entirely new species, which may well be of greater interest to many readers of the *Gazette*. This was achieved by exactly the same method as that employed to reconstruct *A. adulterinum*. Artificial polyploid species are well known in flowering plants (*viz.* CLAUSEN, KECK, & HIESEY 1945, p. 70 *et seq.*), but none has previously been reported in ferns.

The new artificial species is an allotetraploid constructed from *Asplenium viride* Hudson and *A. fontanum* (L.) Bernh. These two diploid species grow together not uncommonly in nature. The wild hybrid between them has been described and figured (CHRIST 1900, pp. 88 & 89; MEYER 1957, p. 59; 1962, p. 25), and is known as *A.* × *gastonii-gautieri* Litard. (LITARDIERE 1911, p. 247)** but does seem to be extremely rare and, so far as is known, occurs only as isolated examples. There is no evidence to suggest that a tetraploid form has yet succeeded in establishing itself in nature. No living wild specimens of the hybrid have been available to me for study. An example found by Dr D. E. MEYER (1957) at Lauchfluh near Basel on 4th June 1954 unfortunately did not survive long in cultivation, and provided him with only an imprecise chromosome count which was in all probability made on a broken cell; it is scarcely conceivable that the number recorded ($2n = 54$) could arise in *Asplenium* (which has a base number of $x = 36$), and would in the event almost certainly be inviable.

Primula kewensis is perhaps the best known artificial species, but since this plant arose more or less accidentally in cultivation (and for cytogenetic reasons which need not concern us here), a better example of a synthetic allopolyploid is the radish/cabbage hybrid, *Raphanobrassica*, synthesised by KARPECHENKO (1927, 1928). *Raphanobrassica* illustrates very well the origin of a classic allotetraploid from two diploid species. The diploid hybrid *Raphanus sativus* × *Brassica oleracea* is sterile, meiosis aborting on account of the chromosomes contributed by the parents being so distinct that they are unable to pair. However, the abortion of meiosis leads to the production of some unreduced (diploid) gametes, and self-pollination produced a very low yield of tetraploid progeny resulting from union of these diploid gametes. In these progeny plants four chromosome sets are present, two from *R. sativus*, and two from *B. oleracea*. Meiosis is now regular, because each chromosome has an identical partner present. In consequence, fertility is restored. Thus, once created, the allotetraploid can readily reproduce itself. It will breed true to type, because the partners in homologous chromosome pairs are genetically identical, on account of their recent origin by duplication from the same chromosome. Furthermore, it is effectively genetically isolated from its original diploid parents, since back-cross hybrids formed between either of the diploids and their tetraploid product will be triploid, and therefore sterile, on account of the irregular nature of the meiotic division.

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**The earlier name *Asplenium* × *gautieri* Christ, in BURNAT (1900, p. 15), is illegitimate, being a later homonym of *A.* × *gautieri* Hk. (HOOKER 1860, p. 88, t. 144).

The techniques of culture and hybridization used in the synthesis of *Asplenium viride* × *fontanum* are those which were described recently in the *Gazette* (LOVIS 1967) and therefore need not be considered further here.

Four attempts to hybridize *Asplenium viride* and *A. fontanum*, totalling 32 prothalli, were made on 24 August 1963, all with *A. viride* as the female parent. One hybrid was obtained. The localities of origin of the parent strains are:

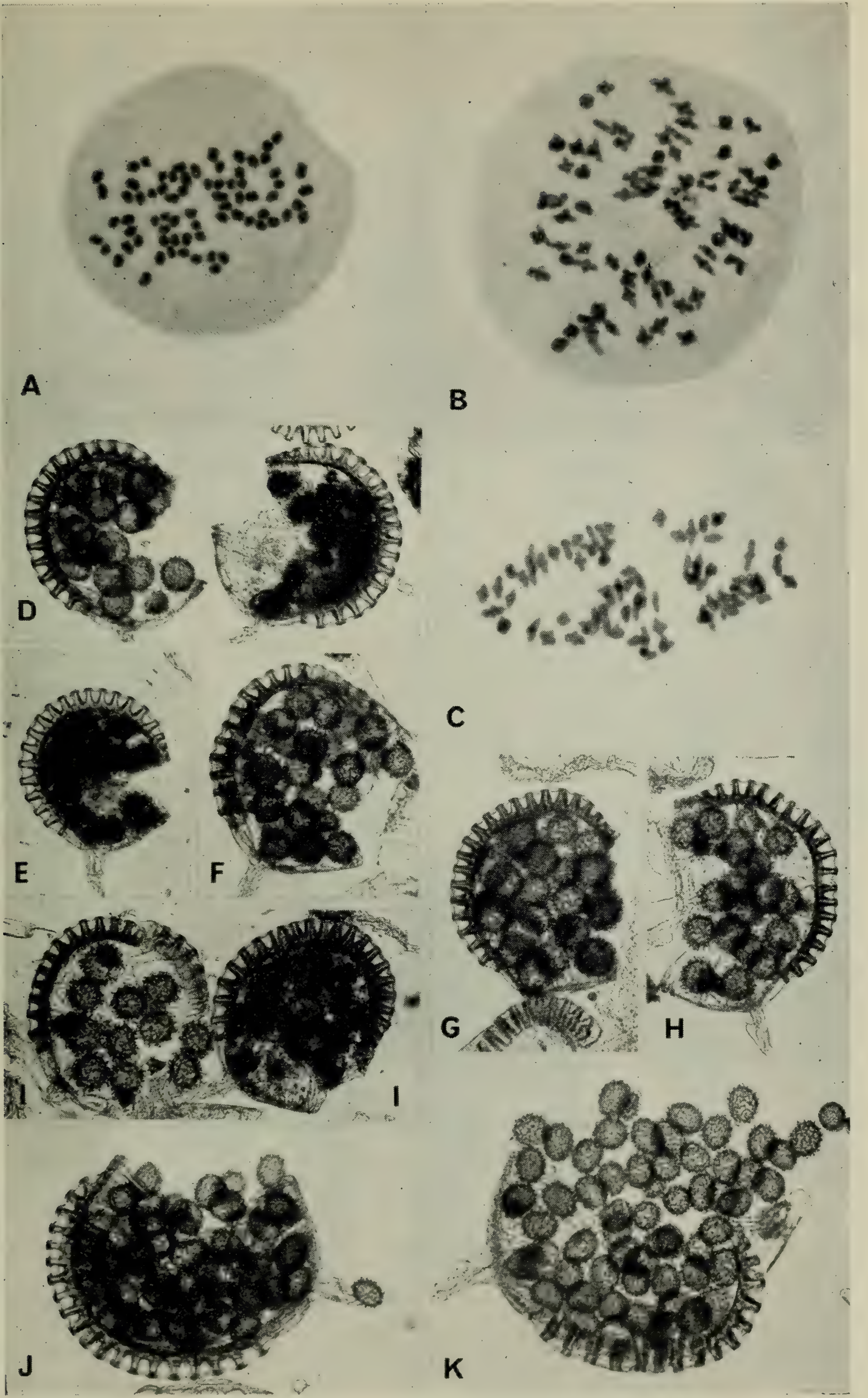
A. viride: Bains de Tredos, Central Pyrenees, coll. D. D. Bartley, 1959.
A. fontanum: Pas au Col Vert, near Villard de Lans, Dept. Isère, France, coll. A. H. G. Alston, 1949.

The *Asplenium viride* × *fontanum* hybrid, just like *Raphanus sativus* × *Brassica oleracea* and *A. viride* × *trichomanes* ssp. *trichomanes* (the progenitor of *A. adulterinum*, LOVIS 1968), shows complete failure of chromosome pairing in meiosis (Pl. XVII A). 72 univalents are present, and in consequence the meiotic division fails. However, the spores produced as a consequence of this aborted meiosis proved to be not so uniformly sterile as one might expect. Sowings were made with the result that a significant proportion of the spores germinated, and furthermore developed into normal prothalli with functional sex organs. In due course, selfing of these cultures yielded 122 sporophytes. Four of them proved to be contaminants, but the remaining 118 plants all showed the expected morphology. All of these progeny plants which have been examined show normal and regular spore production. Five plants have been studied cytologically. All are tetraploid, with regular meiotic pairing (Pl. XVII **B** & **C**). 72 bivalents are present, of which 36 must be formed by pairing between the two *viride* chromosome sets present, and the other 36 from the chromosomes derived from *A. fontanum*.

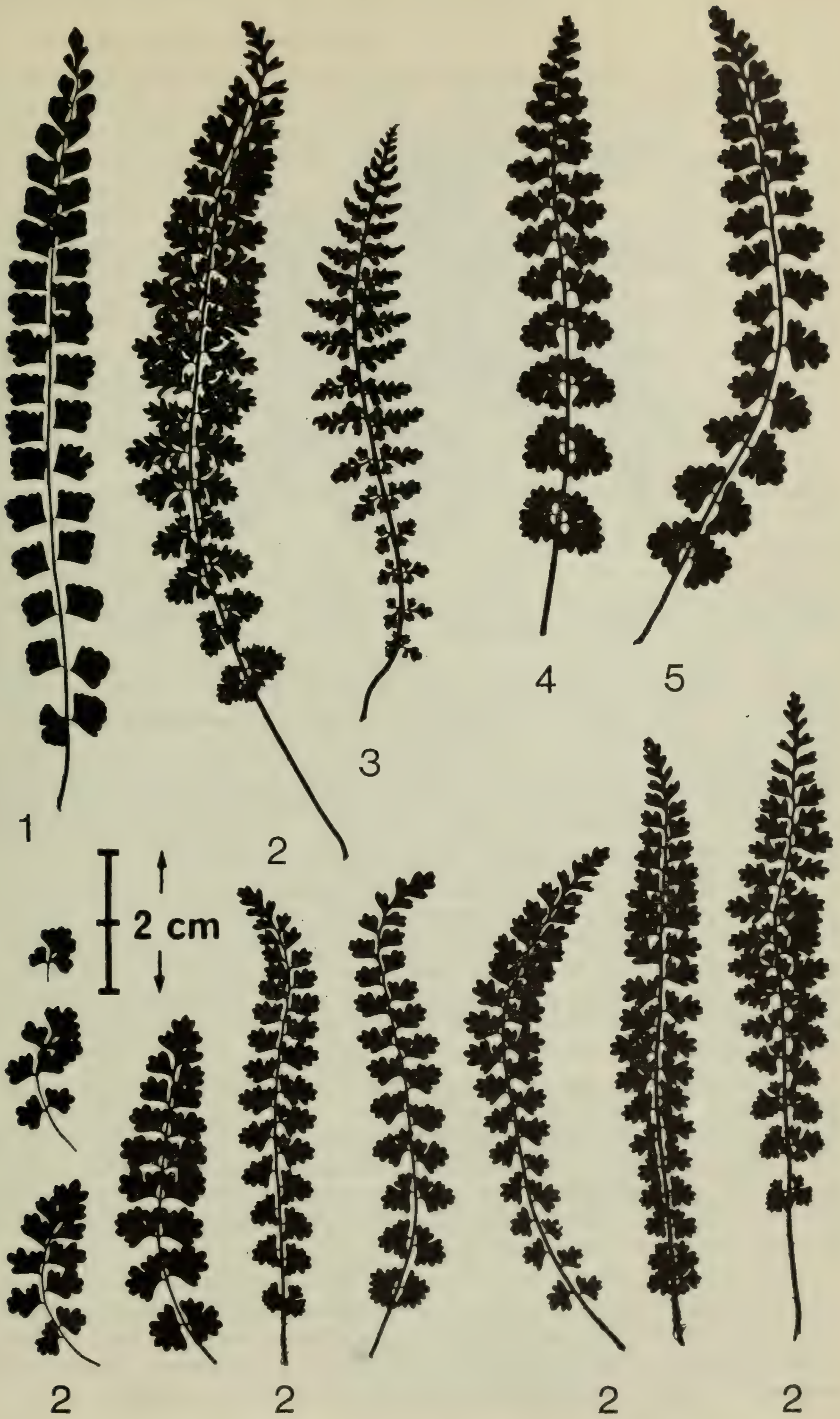
Exactly the same sort of result has been obtained from sowings of the synthetic diploid hybrid *Asplenium viride* × *trichomanes* spp. *trichomanes* (LOVIS 1968), from the comparable wild hybrid of this same parentage and from the wild hybrid *A. viride* × *trichomanes* ssp. *inexpectans* (LOVIS & REICHSTEIN 1968 a, b). It is clear that the cause of this unexpected fertility is the same for *A. viride* × *fontanum* as in these other hybrids. The proposed explanation of this phenomenon which has been published was written in German (LOVIS & REICHSTEIN, *loc. cit.*), so there is some virtue in repeating it here.

In each of these four diploid *Asplenium* hybrids, it is found that although some mature sporangia contain nothing but abortive material (e.g. Pl. XVII **E**), others contain a variable number of spores of viable appearance. Some of these sporangia contain only a few well-formed spores surrounded by much abortive material, but others are almost completely filled with spores of good appearance, little abortive material being present. In *A. viride* × *trichomanes* subsp. *inexpectans* these sporangia contain most frequently about 10 or 11 spores. *A. viride* × *fontanum* differs from the *A. viride* × *trichomanes* hybrids in that a somewhat higher proportion of sporangia contain mostly spores of functional appearance. The number of these frequently approaches 16, sometimes even exceeding this figure, as many as 26 well-formed spores having been observed in one sporangium (Pl. XVII **G**).

PLATE XVII: **A – C**, permanent aceto-carmine preparations of first metaphase of meiosis magnification × 1000. **A:** *Asplenium viride* × *fontanum*, JDL 1281, diploid, showing 7 univalents. **B, C:** tetraploid progeny ex JDL 1281, showing 72 bivalents (**B**, plant 1A; C plant 6B). **D – K**, glycerine jelly mounts of sporangia, magnification × 100. **D – I:** *A. viride* × *fontanum*, JDL 1281. **J & K:** tetraploid plant 6D, progeny *ex* JDL 1281.



facing page 154



FIGURES 1 – 5: Silhouettes of fronds, natural size, all from cultivation at Leeds. Fig. **1:** *Asplenium viride*, ex Bains de Tredos, Pyrenees. Fig. **2:** *A. viride × fontanum*, JDL 1281 (bottom row displays stages in development). Fig. **3:** *A. fontanum*, ex Villard de Lans, Isère. Figs. **4** & **5:** tetraploid progeny ex JDL 1281. Fig. **4:** plant 1A, Fig. **5:** plant 6F.

These spores differ in number, shape, and size from those found in the tetraploid plants of *Asplenium viride* × *fontanum*, in which the sporangia are of quite normal appearance (Pl. XVII **J** & **K**), and contain 64 spores, as is typical of the sporangia of most sexually-reproducing leptosporangiate ferns (the spores are produced as a consequence of meiotic division in each of 16 spore mother cells, each mother cell producing a tetrad of four spores). The spores formed by the diploid hybrid are almost spherical in shape, in contrast to the approximately plano-convex shape of those of the tetraploid. They are also, although very variable in size, usually appreciably larger, typically measuring about 45 × 43μm The average dimensions of a sample of the spores of the tetraploid are 48 × 39 μm.

The key to the explanation of these differences lies in the cytology of meiosis in the diploid hybrid. Cells in the first metaphase stage are abundant, but little evidence has been seen of later stages in meiosis. Although a careful study of the subsequent stages in the formation of the spores has not yet been made, there is a very strong *prima facie* case that meiosis frequently aborts after a prolonged metaphase, followed by reconstitution of the mother cell nucleus. Subsequently, some of the mother cells may proceed to formation of a single spore, without any further attempt at cell division. Being produced thus without reduction of chromosome number, these spores will be diploid. The prothalli they produce will be uniformly diploid, and self-fertilisation of these gametophytes will consequently result in the production of tetraploid sporophytes.

The number and shape of the spores produced by the diploid hybrid supports such an interpretation (the plano-convex shape of the spores of the tetraploids, like those of other species of *Asplenium*, is associated with their formation in closely appressed tetrads), as does the consistently tetraploid nature of the sporophytes obtained as progeny from the diploid hybrids. It is significant that the tetraploid *Raphanobrassica* arose in a comparable way, by self-pollination resulting in the union of unreduced (i.e., diploid) gametes. In this case, the formation of unreduced sex cells in the diploid hybrid was actually observed.

It was mentioned above that the diploid *Asplenium viride* × *fontanum* hybrid differs from the *A. viride* × *trichomanes* hybrids in that its sporangia sometimes contain rather more than 16 spores. Thus the number of spores is sometimes larger than the number of spore mother cells. The cause of this complication is uncertain, but more than one explanation is possible, and there is no reason to assume that this circumstance invalidates the interpretation of the origin of the tetraploid progeny proposed here.

Asplenium viride and *A. fontanum* differ most conspicuously in the deep dissection of the pinnae of the latter species. The new tetraploid species, *A. viride* × *fontanum*, is intermediate between its parents with regard to this and other characters, and it is not without merit as an ornamental fern. I should be very glad to supply spores to anyone who would like to attempt its cultivation. It has proved to be quite vigorous and relatively long-lived in the greenhouse, but has not yet been tested outdoors.

It is a pleasure to thank Prof. Manton and Prof. Reichstein for their encouragement and interest, Mr J. A. Crabbe for valuable assistance in obtaining literature, and the staff of the Experimental Gardens of the Department of Botany, University of Leeds, especially Mr Peter Lee and Mr Frank K. Horwood, for their skilful and patient care in cultivation of the plants used in this investigation.

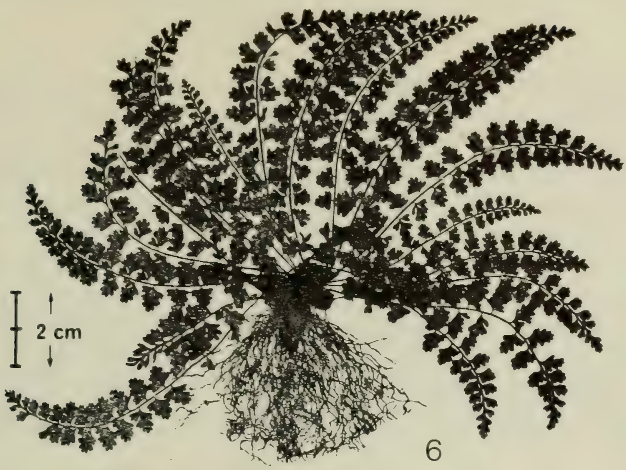


FIGURE 6: Silhouette of whole plant, *half* natural size, from cultivation at Leeds. Tetraploid plant 6D, progeny *ex* JDL 1281, *Asplenium viride* × *fontanum.*

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THE BPS EXCURSION 1969 TO LAUNCESTON

J. W. DYCE

Approaching Launceston from the east, this ancient Cornish capital is seen perched on a hill, dominated by its ruined castle. Entry through the old South Gate into a network of narrow streets where one-way traffic is a necessity, completes the picture of a beautiful old medieval town with many fine buildings and old churches. Near the Castle, our centre, the Eagle House Hotel, stood on high ground and here our party gathered on Saturday, 30th August.

In the town itself are many old walls, well covered with ferns, and *Asplenium adiantum-nigrum*, *A. ruta-muraria*, *A. trichomanes*, *Phyllitis scolopendrium* and *Polypodium interjectum* were common, as well as some *Athyrium filix-femina* and *Dryopteris filix-mas* at the wall bases. In the hotel car-park *A. ruta-muraria* grows abundantly in a variety of forms with fronds ranging from long narrow-pinnuled ones to short ones with large rounded pinnules. These provided quite a lot of interest.

Studying our maps, we noted a few miles from Launceston the wooded slopes on the north-east edge of Bodmin Moor, and here we started work on the Sunday. On our way we paused at South Petherwin to pick up the members staying there. They had already recorded the ferns around the village, 12 in all, including the wall ferns (*A. ruta-muraria*, *A. trichomanes*, *P. scolopendrium*, *P. interjectum* and *P. vulgare*), and some of the larger ferns (among them *Polystichum setiferum*). In the River Inny valley near Trekelland a very similar list was made, then we went on to stop at Berriowbridge where the narrow lanes made parking for several cars rather difficult. We devoted some time to this spot before lunch, but again our records were very much the same. In the afternoon we explored Hawk's Tor and Twelve Men's Moor in the same area, and now began to see some of the less common ferns which during the week helped to give us such a good total of finds. Both species of *Hymenophyllum* were on the rocks of the tors, as well as *A. billotii*, and even a few small plants of *D. aemula* in a seemingly not too suitable habitat. The only polypody was *P. vulgare*, and some of the larger ferns with *Pteridium aquilinum* completed the list.

On this first day we only touched the fringe of Bodmin Moor, but we returned again later in the week to penetrate more fully into its wilder parts. We did not expect to find an abundant fern flora, but some of the less common allies have their abode there. In Dozmary Pool, a large stretch of desolate water surrounded by bare moorland and famed as the " level lake " into which Sir Belvedere flung King Arthur's sword Excalibur, we found *Isoetes echinospora*, but the only ferns seen were *A. filix-femina*, *D. pseudo-mas* (*borreri*), *D. austriaca* (*dilatata*), *D. filix-mas*, *Thelypteris limbosperma* and *Blechnum spicant*. In Redhill Marsh we hoped to find *D. carthusiana*, but the ground was too treacherous to allow a proper search. However, we did find some plants showing well the hybrid characters of *D. carthusiana* and *D. austriaca*, and no doubt *D. carthusiana* itself is also there. Continuing south, we dropped down from the moors into the valley of the Fowey at the Halfway House Inn where ferns were more numerous again, and *A. adiantum-nigrum*, *A. trichomanes*, *P. scolopendrium*, *P. interjectum* and *P. vulgare* were common on the bridge and walls. The large woodland ferns were abundant, and on the banks of a rough track leading up the slope on the south side of the river several large plants of *D. aemula* were noted.

Travelling to the south-west down the Fowey valley still in search of the unusual, we visited Red Moor Ponds, an extensive collection of many pools which are a recorded locality for *Pilularia globulifera.* We were fortunate in finding a large patch of this fern growing like a luxuriant grass on boggy ground. Nearby in one of the ponds was a magnificent stand of *Equisetum fluviatile*, and as might be expected, *Osmunda regalis* was also there. The only other ferns were *A. filix-femina*, *D. pseudo-mas*, *D. austriaca*, *D. filix-mas*, *B. spicant* and the ubiquitous *P. aquilinum.* Following up more information, we continued westwards to Carbis Moor, south of Penwithick Stents, to look for *Lycopodium inundatum.* Again we were lucky, and discovered this clubmoss in the first wet hollow we searched, growing most profusely over the whole area. Probably it is equally abundant in the many other adjacent hollows, but we did not have time to confirm this. Growing with it was *O. regalis*, many young plants appearing in the same wet hollow with the clubmoss. Two horsetails, *E. fluviatile* and *E. palustre*, were also there, with *A. filix-femina*, *D. pseudo-mas*, *D. austriaca*, *B. spicant* and *T. limbosperma.*

Launceston is not far from the coast, and with thoughts of the Maidenhair Fern *Adiantum capillus-veneris* in mind, a day in the Tintagel area was planned. We found a parking place near the entrances to St Nectan's Glen and the Rocky Valley, the former running inland, the latter towards the sea. Permission was kindly given to us by the owner of one side of the Glen to hunt through her property, but it was a wild scramble through bogs, brambles and nettles which prevented a very thorough exploration, so that we did not see ferns which we are sure should be there, such as *H. tunbrigense* and *H. wilsonii.* Conditions were right for *D. carthusiana* as well but this fern was not seen. There were places too where one could have expected to find either one or both of the lowland species of *Polystichum*, but they were conspicuous by their absence. The habitat seemed ideal for *O. regalis*, yet only a few isolated specimens were seen. The only other species noted were *A. filix-femina*, *D. pseudo-mas*, *D. austriaca*, *D. filix-mas*, *B. spicant* and *P. scolopendrium*, and on the higher ground further up the Glen we added *Cystopteris fragilis*, *P. interjectum* and *D. aemula* to the list. It was again an unusual habitat for *D. aemula*, on an open scree in a quarry at the top of the Glen.

The Rocky Valley is a continuance, on the coast side of the road, of St Nectan's Glen but is steeper and narrower with cliff sides. In addition to most of the ferns already seen, the Valley contained *A. adiantum-nigrum* and *A. trichomanes*, while near the sea we found *A. billotii* and *A. marinum*, the latter forming large clumps in the rock crevices. Best of all, we were able to see and admire a magnificent colony of *A. capillus-veneris* covering the face of a wet cliff, a most pleasing sight, for the large-growing fronds were fresh and bright-green, draping the rocks with a curtain of delicate beauty. This was one of the high-spots of the Excursion.

To the south-east in the Tamar valley, Peter Corbin obtained permission for us to visit Endsleigh, a former seat of the Dukes of Bedford but now a hotel. The house stands on high ground overlooking the valley and a fine sweep of the river, along which we hunted for some way, finding *O. regalis* overhanging the water but very battered by recent flooding. Large-growing *P. setiferum* was common along the river track, together with *A. filix-femina*, *B. spicant*, *D. pseudomas*, *D. austriaca* and *D. filix-mas*. On the higher ground near the house we added *A. adiantum-nigrum*, *A. trichomanes*, *P. scolopendrium* and *P. interjectum* to our finds. The garden and grounds are very much overgrown, but an old rock-garden with a and grotto the remains of an old fern collection was seen, and we noted some good varieties still growing well, particularly of *P. setiferum* and *Dryopteris*. Since no one is interested in them, Peter Corbin requested and received permission to go back at his convenience and remove them to his own garden. It is appropriate to mention here that in his garden at Horrabridge grows a fine plant of *P. scolopendrium* 'Sagittato-crispa', one of his own finds in his home area and one with which to be well pleased.

From Endsleigh on the way to see another fern ally, *Isoetes lacustris*, we passed through Horrabridge where, during a brief stop, we found the walls well covered with *A. adiantum-nigrum*, *A. ruta-muraria*, *A. trichomanes*, *P. scolopendrium* and *Ceterach officinarum*. We also noted *A. filix-femina*, *D. filix-mas*, and *P. setiferum*. The quillwort grows in a pool near Blackaton Cross in an area of china clay pits, and we had no difficulty in finding it. Very few ferns grow here, and only some *A. adiantum-nigrum*, *A. trichomanes*, *P. scolopendrium* and a polypody were seen on walls and banks, along with a few plants of *A. filix-femina*, *B. spicant* and *D. austriaca*.

We appeared to be neglecting the ground to the north of Launceston and decided on the Thursday to remedy this by exploring up the Tamar and Carey valleys. This is more of an agricultural area and not very rich in ferns. We stopped at many places and found the distribution pattern similar in all of them, and in only two did we find a more uncommon fern: a few plants of *D. aemula* growing on a bank along the edge of some woodland on Sellick Moor, and a colony of *D. carthusiana* by the old canal near Boyton. The other ferns noted were *A. filix-femina*, *B. spicant*, *D. pseudo-mas*, *D. austriaca*, *D. filix-mas*, *P. scolopendrium*, *P. setiferum*, *P. aquilinum* and on some walls *A. adiantum-nigrum*, *A. ruta-muraria*, *P. interjectum* and *P. vulgare*. Our younger members chose to return to Bodmin Moor on this day and recorded many ferns from Brown Willy, the highest of the tors on the Moor, including the two species of *Hymenophyllum*, *P. interjectum*, *P. vulgare* and *T. limbosperma*.

On our last day our eyes turned to the east, and we were led by Peter Corbin to the edge of Dartmoor to visit an old quarry, very overgrown and extensive, near Bridestowe. There was a wealth of ferns here, but most exciting were the scree slopes literally covered by a vast number of huge plants of *Ceterach officinarum*. Also on the same slopes were magnificient plants of *A. adiantum-nigrum* and *A. trichomanes*, while *A. ruta-muraria* was also common. In the wooded areas were *A. filix-femina*, *B. spicant*, *D. pseudo-mas*, *D. austriaca*, *D. filix-mas*, *P. scolopendrium* and *P. vulgare*, and in one deep excavation was a large colony of *P. aculeatum*, accompanied by some *P. setiferum*. From here we went to Lydford Gorge, an impressive ravine, but not as well enriched with ferns as one would expect. It seemed an ideal place for the hymenophyllums but we could not find any. *A. adiantum-nigrum* and *A. trichomanes* in small numbers, *A. filix-femina*, *B. spicant*, *D. pseudo-mas*, *D. austriaca*, *P. scolopendrium*, *P. interjectum*, *P. setiferum* and *P. aquilinum* were seen, along with two plants of *D. aemula*, but there was no sign of *P. aculeatum* which again was a fern we felt should have been happy there.

On the Saturday the remaining members of our party scattered in their several directions, and on the way home via Okehampton two of us stopped at Meldon Quarry to find again on the stony slopes, as in the other quarry, similar luxuriant growth of *A. adiantum-nigrum*, *A. ruta-muraria* and *A. trichomanes*, along with an abundance of vigorous *C. officinarum*. It made a fitting end to the Excursion.

In the following list of ferns seen during the Excursion, figures 1–26 (***bold*** = new record, * = confirmation of pre-1930 record, for the *Atlas of the British Flora*) refer to the localities:

Adiantum capillus-veneris—13
Asplenium adiantum-nigrum—1, 2, 7, 8, 10, 13, 16, 18, 19, 20, 21, 22, 23, 24
A. billotii—9*, 13
A. marinum—13
A. ruta-muraria—2, 3, 10, 14, 19, 20, 21, 24
A. trichomanes—***1***, 4, 7, 8, 10, 13, 14, ***16***, 18, 19, 21, 23, 24
Athyrium filix-femina—1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. 17, 18, 19, 21, 22, 23, 24, 25, 26
Blechnum spicant—1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14, 15, 16, 17, 18, 21, 22, 23, 25, 26
Ceterach officinarum—19, 21, 24
Cystopteris fragilis—***15***
Dryopteris aemula—***8***, ***9***, ***15***, ***23***, 26
D. austriaca—1, 3, ***4***, 5, ***6***, 7, 8, 9, ***11***, ***12***, 13, 14, 15, 16, 17, 18, 21, 22, 23, 25, 26
D. carthusiana—***3***
D. filix-mas—***1***, 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, ***16***, 19, 20, 21, 22, 24, 25, 26
D. pseudo-mas—***1***, 3, 4*, 5, 6*, 7, 8, ***9***, 12, 13, 14, 15, ***16***, ***17***, 21, 22, 23, 24, 25, 26
Equisetum arvense—5
E. fluviatile—***5***, ***12***
E. palustre—5
Hymenophyllum tunbrigense—4*, 9*, 17*
H. wilsonii—***4***, 9*, 17*
Isoetes echinospora—6
I. lacustris—18
Lycopodium inundatum— ***5***
Osmunda regalis—5, ***7***, 12, 15
Phyllitis scolopendrium—2, 3, 7, 8, 10, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 25
Pilularia globulifera—***12***
Polypodium interjectum—1, 4, 7, 8, 10, 13, 14, 15, 16, 22, 23, 24, 25
P. vulgare *sensu stricto*—1, 3, 4, 8, 9, 11, 14, 17, 20, 21, 24, 26
P. vulgare *sensu lato*—18
Polystichum aculeatum—21, ***24***
P. setiferum—2, ***7***, 14, ***16***, ***19***, 21, 22, 23, 24, 25
Pteridium aquilinum—1, 3, 4, 5, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 21, 23, 24, 25, 26
Thelypteris limbosperma—1, 4, ***5***, 6, 8

	V. C. 2 East Cornwall (*O.S.* 1 *in. map ser.* 7 *sheet* 174)	Date visited Aug./Sept.	National Grid ref.
1	Berriowbridge	31	20/2775
2	Boyton	4	3191, 3192, 3291, 3292
3	Boyton, Old Canal	4	3292
4	Brown Willy	4	1579
5	Carbis Moor	2	0356
6	Dozmary Pool	2	1974
7	Endsleigh	3	3878, 3978
8	Halfway House Inn	2	1564, 1565
9	Hawk's Tor	31	2576

10	Launceston	30–6	3284, 3384
11	Redhill Marsh	2	1672
12	Redmoor Ponds, near Tredinnick	2	0762
13	Rocky Valley	1	0789
14	South Petherwin	30–6	3081, 3082, 3181, 3182
15	St Nectan's Glen	1	0788, 0888
16	Trekelland	31	2979
17	Twelve Men's Moor	31	2574, 2575

V.C. 3 South Devon
(*O.S.* 1 *in. map ser.* 7 *sheet* 187)

18	Blackaton Cross	3	5763
19	Horrabridge	3	1569

V.C. 4 North Devon
(*O.S.* 1 *in. map. ser.* 7 *sheets* 174, 175)

20	Ashwater	4	3895
21	Bridestowe Old Quarry	5	5289
22	Luffincott	4	3394
23	Lydford Gorge	5	5083, 5084
24	Meldon	6	5692
25	River Claw, near Tetcott	4	3296
26	Sillick Moor	4	21/3300

REVIEWS

THE VICTORIAN FERN CRAZE, A HISTORY OF PTERIDOMANIA by David Elliston Allen, 85 pages, illustrated in black-and-white. 14×21.7 cms, Hutchinson, London, 1969. Price 21 shillings (pounds 1.05).

For over 30 years I have lived close to ferns and fern men—and to fern books. The books have a great fascination with their wealth of information and the enthusiasm of the many authors who churned them out in vast numbers during the latter half of the 19th century and gave a very vivid picture of the "fern craze". I thought I knew a lot about its history until I read this book by David Elliston Allen who has skilfully captured the picture of the period and made it live in his pages. We feel the excitement of the hunt for new fern varieties, bad ones and good ones, and their subsequent development in garden and greenhouse, and above all we feel the excited urge for more and more information and the avid seizing of each new book as it poured from the presses. The author is to be congratulated on the very successful outcome of the large amount of labour and research which has gone into this production, bringing into small compass so much new and interesting information.

The subject matter would not seem to lend itself to the making of an interesting and successful book and we would expect it to be a dry recital of many facts. The first stimulus to the fern cult was the discovery of reliable spore-raising methods which encouraged the growing of many exotic ferns and launched the fern trade. Next came the Wardian Case which provided the growing conditions for easy culture, and this was followed by an awakening interest in our British ferns and their varieties. Then came the books in ever-increasing numbers until the end of the century when the " craze " was fast declining. The story is written by Mr Allen in a graphic manner which holds our interest, and sums up the whole period, bringing its fevered craziness into true perspective.

To the present-day pteridologist the book is a revelation—and a warning! The wind of commonsense blows through it. Ferns are still an absorbing subject with the power to obsess, and with today's revival of interest in them we need the antidote provided by Mr Allen who signposts the dangers and the absurdities which can still beset us, and helps us to preserve a balanced outlook on ferns.

This delightful small book should be read by everyone interested in ferns. It is excellently produced by Hutchinsons, and has several fine black-and-white illustrations taken from the literature of the period. It is certainly very good value for 21s.

J. W. DYCE

Here is a different book about ferns and the mania ferns wrought in the nineteenth century among those who fell under their prothalli. Here is sociology of fern collectors and particularly of those who grew ferns in closely glazed cases. Nathaniel Bagshaw Ward, "a surgeon in practice in the docklands of Whitechapel," popularized the idea that plants may live and grow in the microbiome of a properly prepared sealed glass case. W. J. Hooker, director of the Royal Botanic Gardens, Kew, wrote Ward in 1842 that his cases "for the in-door cultivation of tender plants are deservedly great favourites, and have contributed to the enjoyment of many families both in town and country. Splendid as is the hot-house and green-house collection at Woburn Abbey, I doubt whether that gives more pleasure to the noble proprietors and their numerous visitors than the beautiful little collection in *Mr Ward's case* that occupies a table in the library, and flourishes without requiring the skill of the gardener in its cultivation."

This little volume of seventy-two pages is a whimsical *divertissement* for an afternoon, but it also will be picked up to settle a point. The book is altogether a pleasing crosier of the bookmaker's art, for choice of paper (to prevent wilting when carried into the Hymenophyllum house), for printing, binding, and end-papers (which incidentally may allude to the social note that the "fern craze opened [about 1840] as men's clothes turned black").

Allen traces the history of serious fern study from Robert Morison, who came close to apprehending the gametophyte-sporophyte alternating life cycle, and William Sherrard, who discovered a sport of a lady fern in 1690, down to John Lindley and his protegé Thomas Moore, the " supreme and unchallenged high priest of the cult." It is possible to go back to Tradescant's 'Ark' of the early seventeenth century, for it sheltered at least two fern exhibits: oil of capillaire and the vegetable lamb of Tartary, apart from the live rhizomes John Tradescant the Younger may have brought back from Virginia. In 1771 John Ellis published an illustrated tract on the shipping of living plants overseas in cases designed for shipdeck or captain's quarters. These were used especially for crop plants, and Bligh's breadfruit seedlings eventually voyaged to the West Indies in a similar frame.

This history relates to the beginnings of vivaria and aquaria, both advanced by Ward. The use of glass for greenhouses was long restricted by the revenue tax on glass. "The ultimate triumph of glass in architecture" followed the repeal of the glass tax. Joseph Paxton's Crystal Palace at the Great Exhibition of 1851 dramatized how magnificent is foliage under glass, from arching palms to the tufts of ferns about their boles. It encouraged the use of glass cases in the home.

Conrad Loddiges & Son of Hackney, which Ward "justly styled 'Hortulanorum Principes '," particularly stimulated the use of closely glazed cases. Loddiges, too, were active importers of ferns from distant lands. Two botanic gardens, those at Glasgow and Liverpool gave prominence to ferns. And two amateurs, Robert Barclay of Bury Hill and John Riley of Papplewick, early collected ferns for their glass houses. These living collections demonstrated what variety and beauty might be grown in home ferneries. Orchid growing enjoyed a rising popularity at the same time as the 'Victorian fern craze' and Loddiges, among nurserymen, featured both orchids and ferns.

Allen mentions that George William Francis, who was a fillip with his modestly priced books on fern cultivation, " evidently burdened by too large a family, emigrated to Australia," where he became director of the botanic garden at Adelaide. Judging from the biography of Francis by his descendant, Barbara J. Best, it was his failure to gain the Chair of Botany at King's College, London, in spite of a testimonial from Ward, J. E. Sowerby, and others, that led him to emigrate. Note also that Thomas Moore assumed the mantle of his mentor Lindley and brought to publication the immensely useful *Treasury of Botany*, revised and enlarged as late as 1889, aside from his critical pteridological works.

In the larger historical view the fern craze, orchid mania, shell collecting, and pressing seaweeds from far and near, were all manifestations of a nineteenth century release born of rising salaries and more leisure among middle-class Britons. Incidentally the history of hanging baskets in American homes (p. 60) has evidently not been looked into. It is interesting that American nurserymen M'Mahon, Thorburn, and Buist do not mention hanging baskets.

JOSEPH EWAN

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Printed by the Devonshire Press, Torquay, England

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THE BRITISH FERN GAZETTE

VOLUME TEN PART FOUR

1971

THE JOURNAL OF THE
BRITISH PTERIDOLOGICAL SOCIETY

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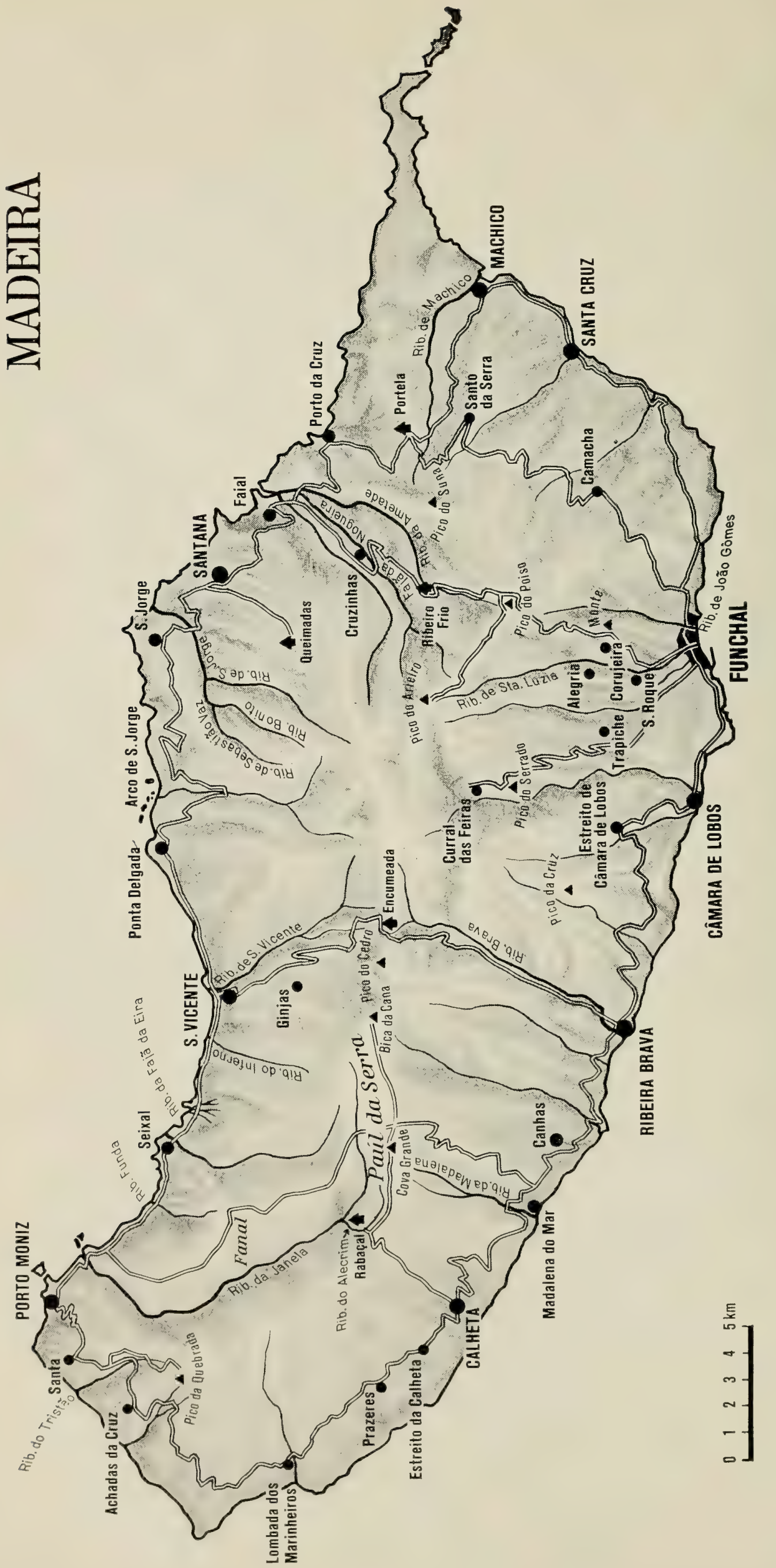
BRITISH FERN GAZETTE VOLUME 10 PART 4

THE BRITISH FERN GAZETTE Volume 10 Part 3
was published on 3 October 1970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Portela
Santo da Serra
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FERN HUNTING IN MADEIRA

G. BENL*

INTRODUCTION

Madeira, the famous subtropical trade-wind island, lies on about the same latitude as Casablanca and the Bermudas. Covering 728 sq. km (57 km long, up to 22 km wide) it is the largest of a group of islands which include also Porto Santo, Deserta Grande, Chão and Bugio. Like the Canary Islands and the Açores the Madeiran Archipelago is of volcanic origin, mainly basaltic lava and tuff. Large parts of the main island consist of a system of mountains often rising directly from the shore, but reaching 1861 m (Pico Ruivo) only in the rugged central chain dividing Madeira into a northern and a southern part (see map opposite).

LOCALITIES IN EASTERN MADEIRA

To obtain a first impression of Madeira's wealth in ferns the visitor should take a walk along the eastern levada of **Ribeiro Frio**, a convenient shady footpath beside the narrow water-course, at about 900 m above sea-level. It begins quite near the first Teahouse (called "Trout Inn") on the highway from Funchal to Faial.

The almost perpendicular rock-face (2-3 m in height) beyond the water channel is curtained by thousands of the dominant *Blechnum spicant* L. covering sizeable areas along almost any levada, and *Thelypteris pozoi* (Lag.) C. V. Morton with its leaf-segments hairy on both surfaces like *Cyclosorus dentatus* (Forsk.) Ching; but the former is easily recognizable by its linear blackish sori. It will be found growing in rather dry positions (below Prazeres, 500 m) as well as in shady laurel woods (Ribeiro Bonito, 610 m). You will see the many luxuriant fronds (up to 40 cm in length) of *Asplenium monanthes* L., which is so extremely rare, if not actually extinct in the Canary Islands (La Palma). In Madeira, on the contrary, you can scarcely walk along a levada without noticing this delicate spleenwort. Its proliferating buds are not restricted to the base of the rhachis but often arise from the axil of the lowest pinna. The plants are reported (MANTON 1950: 195) to be apogamous triploids.

Where small water-courses run down the rocky slopes into the channel, one can admire in the richer soil vigorous colonies of *Polystichum setiferum* (Forsk.) Woynar (including the variation with sub-tripinnate fronds), *Pteris serrulata* Forsk., *Diplazium caudatun* (Cav.) Jermy, *Trichomanes speciosum* Willd. along with *Dryopteris pseudomas* (Woll.) Holub & Pouzar, *D. aemula* (Ait.) O. Ktze., *D. aitoniana* Pic. Ser. (syn. *D. macaronesica* Romariz) and the huge leaves of *Woodwardia radicans* (L.) Sm., more than three metres in length. The latter, so-called "Button Fern" ("Feto botão") is favoured by the Madeiran climate to such an extent, that it is even spreading in peasants' gardens, mainly in the north of the island.

If you follow the good walking surface of the levada (it will take about four hours to reach Santo da Serra), the profusion of ferns will increase and the clear, golden-green leaves of *Thelypteris limbosperma* (All.) H.P.Fuchs begin to appear. Near and at Pico do Suna (1130 m) the Mountain fern (called "Heather fern" in Madeira) is abundant. Amongst other locations it inhabits the eastern "Levadas de Portela" (650 m) and the "Parque das Queimadas" to the west (870 m). Furthermore we recorded this species in westerly regions of Madeira, for instance in the district of Fanal ("Levada do Fanal" 860 m; "Alagoa" 1050 m) where in certain places it again becomes very prominent. On no account should *Thelypteris limbosperma* be declared a rare plant of this island ("muito rara", ROMARIZ 1953: 96; VASCONCELLOS 1968: 97).

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Between "Boca do Furado" and "Casa de Agua dos Lamaceiros", at about 850 m, one may discover rich mats of *Hymenophyllum tunbrigense* (L.) Sm. clothing mossy rock-faces and shady banks along the water-courses. This species is indeed very common in laurel woods flourishing on old tree stumps or occasionally on trunks; and it will be found in the vicinity of almost any levada from about 600 to 1200 m in altitude. Like in Tenerife the plant prefers comparatively cool conditions.

In about the same situations *Trichomanes speciosum* will occur. It is not at all rare around the Queimadas, and is even frequent at 570 m and above in the Ribeiro Bonito with its lush woodland species. Furthermore you can see it on the northern slopes of Pico do Cedro (at 970 m), in the "Achadas" (750 m) north of the Encumeada, and especially on the damp slopes south of Rabaçal, where it abounds near the levadas and even becomes epiphytic on the laurel trees.

After having returned to the starting-point ("Casa de Chá de Ribeiro Frio") the fern-hunter may follow the highway by car in a northerly direction. Particularly below Cruzinhas (at 340-320 m) he will notice plenty of *Asplenium aethiopicum* (Burm.) Becherer sprouting from walls by the roadside. This species is locally rather frequent in Madeira. We gathered fine specimens of it (up to 0.5 m in frond length) at some vineyards along and near the north coast (Ribeira de São Jorge 120 m, Ponta Delgada 100 m), where the leaves stay green all the year.

Some metres above the Ribeiro Frio road-surface numerous specimens of *Doodia caudata* R.Br. (Blechnaceae) are growing among the small terraced maize fields. Mentioned by Vasconcellos for the Açores only, it had been collected by Dr G. Schulze (Ludwigshafen) in different spots between Cruzinhas and Faial in 1968 and by A. HANSEN at Monte (1970: 1-2). We moreover recorded this Australian fern by the roadside near Santana and in such a remote place as the Ribeiro Bonito (610 m, on wooded slopes). Naturalization may have taken place in early times. The same may be supposed as concerns the South American *Adiantum raddianum* C. Presl (syn. *A. cuneatum* Langsd. & Fisch.; cf. Alston in Exell, Suppl. Cat. Vasc. Pl. S. Tomé, London 1956: 7), being widely distributed throughout the island, now perfectly established and more abundant than *A. capillus-veneris* L. ("var. *trifidum*" Willd.) at times. *A. hispidulum* Sw. from the Old World tropics, however, was noticed by us only along the Levada de Machico (270 m), where it is growing in community with *Asplenium aethiopicum*, *Blechnum spicant* (including f. *furcatum*), *Cyclosorus dentatus*, *Dryopteris aitoniana* and numerous specimens of *Doodia caudata*. *Adiantum hispidulum*, a handsome hardy fern not uncommon in cultivation, is sure to be a mere garden escape of more recent time, which again Vasconcellos cites only for the Açores.

Another impressive ferny district in the east of Madeira is the **"Parque das Queimadas"**, 880 metres above sea-level and situated about four kilometres inland from Santana. Before you reach the choice locality, you pass a laurel wood concealing a lot of *Hymenophyllum tunbrigense* forming here cushion-like masses on tree stumps, along with plentiful *Dryopteris maderensis* Alston. It is true that the latter, a diploid very similar to *D. intermedia* (Muhl.) Gray, is less frequent than *D. aitoniana*, which can stand a certain amount of dryness in southern ravines (round Estreito da Calheta, e.g.). However, it is frequent in some places: for instance in the Levadas de Portela, the Ribeira de Sebastião Vaz (580 m), the Ribeiro Bonito (610 m) and the Levada da Serra (=Levada dos Brasileiros) on the westerly slope of the Ribeira da Janela (980 m).

Near the Queimadas resthouse you can diverge to the west and follow a delightful path along the levada. Here too the shadowy steep banks along the water-course form a very suitable abode for ferns and are enriched with practically the same species as at Ribeiro Frio. After a fifteen minutes' walk the track will become rougher and then, on the slopes below it, you may be fortunate enough to discover at the foot of an *Erica arborea* L., *Elaphoglossum paleaceum* (Hook. & Grev.) Sledge. This tropical "Lingua cervina", usually known by its incorrect name "*Elaphoglossum hirtum* (Sw.) C.Chr." (cf. PICHI SERMOLLI & SCHELPE 1968) produces tongue-like simple fronds which can be more than 40 cm in length. It generally grows as an epiphyte on roots and branches of *Laurus azorica* (Seub.) Franco or of an *Erica*. Along the Levada do Fanal ("Fanal de Vaz") we recorded this species in little colonies at the feet of *Clethra arborea* Ait. It may be found along the levadas of the Ribeira da Janela at about 700-950 m in altitude. Prof. T. Reichstein (pers. comm.) had noted *Elaphoglossum* on the northern slope of Pico do Cedro (Encumeada) growing there not only epiphytically but on loose shady rocks.

In the same area near the Queimadas one might find what one might call on morphological grounds *Hymenophyllum wilsonii* Hooker. However, Dr J. D. Lovis (Leeds University), whom I met in Funchal, told me that the Madeiran "*Hymenophyllum wilsonii*" known hitherto from the Queimadas and the Boca da Encumeada was not pure *wilsonii* but apparently a hybrid with *H. tunbrigense*. He, therefore, stimulated me to look out for any "*wilsonii*" and to send him material for further cytological investigations.

THE NORTH COAST

A trip to the northern coast of Madeira, especially between São Vicente and Seixal, is indispensable to any fern-lover. Where the Ribeira de S. Vicente falls into the sea, *Asplenium marinum* L. is plentiful at 1-5 m above the sea. Robust plants may here attain frond lengths of more than 30 cm—BUNBURY (1857: 12) had gathered specimens from the same locality "as much as 2 feet high"!

When you enter the **Ribeiro do Inferno**, you will be pleased to find a recently made footpath leading through a wilderness of ferns. *Diplazium caudatum* of nearly man's height will soon be replaced by *Pteris serrulata*; whilst above a hundred metres *Dryopteris aitoniana*, the "Honey fern" (thus named because of its large, sticky sori) is also present, and *Cyclosorus dentatus* occurs with its largest leaves more than 1·2 m long. A waterfall draped by some Woodwardias puts an end to the easy access, but you may force your way by a rougher track on the west side of the rocky ravine. Here one comes across the 3- to 4-pinnate *Polystichum webbianum* (A.Br.) C.Chr., an endemic Madeiran fern. On the ridge of a steeply rising mountain ("Montado dos Pecegueiros") forming the western flank of this ravine there are really fascinating places, where *Culcita macrocarpa* C.Presl rises to the enormous height of four metres. This location, at between 700 and 800 m, seems to be the richest habitat of the "Feto abrum" in the island, comprising about 200 plants, richer even than the respective grounds in Tenerife (Anaga-mountains), where the "peluca" never develops such mighty stocks! It is well known that the long silky hair-like scales of its rhizome are used by native people to staunch bleeding. Fortunately the locality occupied by the fern is private property, and one cannot get access to it without the owner's personal permission. We do hope that the region will eventually be established as a State Nature Reserve. Another station of this precious fern is said to be at "Tis Amarelos", east slope of the S. Vicente valley. HOOKER & BAKER's note (1874: 51) "so abundant that the dense woolly covering of the rhizome has now become an article of commerce", must have referred to the Açores only!

While LOWE (1868: 243) had already called *Culcita macrocarpa* an "excessively rare and local plant" in our island (cf. BORNMÜLLER 1904: 396 "Auch auf Madeira gelang es mir nicht, an den bekannten Standorten ein Exemplar aufzufinden"), the same cannot be said of *Polystichum webbianum* and *Cyclosorus dentatus*. The former is not infrequent in suitable sites and grows near the Ribeira da Faja da Eira (70 m) and in magnificent populations in the Ribeira Funda (400 m).

Cyclosorus dentatus, qualified by ROMARIZ (1953: 97) as "espécie rara" does not only occur at the foot of sunny terrace-walls and rocky slopes in northern regions (e.g. Ribeira de São Vicente, below 300 m; Santa about 400 m) but is also native in the south (Ribeira de Machico 280 m; Ribeira de Santa Luzia 360 m; Ribeira Brava up to 400 m), extending its range mainly west of Ribeira Brava: Ribeira da Madalena 300 m; "Lombada dos Marinheiros" 630 m(!). According to our records this fern can still be considered fairly widespread throughout Madeira, as VAHL (1905: 265) had already recorded it.

About two kilometres west of Seixal several hundred steps lead from the coastal line to the village of **Ribeira Funda** at approximately 200 m above sea-level. Halfway up there is a remarkable occurrence of *Adiantum reniforme* L. var. *reniforme* with unusually large leaf blades (up to 98 mm wide). The kidney fern is not so frequent here as in some of the Canary Islands (La Palma); nevertheless it may not be called a rare fern in Madeira. Quantities of it are seen on the eastern slope of the Faja de Nogueira, a side-valley branching off the Ribeiro Frio highway before you enter Cruzinhas, on the eastern steep wall (at 80-100 m) of the Ribeira do Inferno and the slopes (terraced with vineyards) all the way between Seixal and Porto Moniz, the north-westerly extremity of the island. We moreover listed this species in the Ribeira Brava (100 m), above Ginjas (560 m), in the Ribeira Grande or Ribeira de São Jorge (650 m), in the Ribeira de Machico (280 m) and Ribeira de Santa Luzia (360 m). The var. *pusillum* Bolle was rarely to be seen.

By a scanty water-course, at 150 m, we found splendid specimens of *Asplenium hemionitis* L. with larger frond sizes (to 30 x 15.5 cm) than noticed elsewhere in the island. In Madeira this fern is slightly scarcer and more scattered than in the Canaries (Anaga-mountains in Tenerife; Monte de Cedro in Gomera!). Here we found the small-leaved form (f. *variegatum*) and according to our experience you may find the "Feto de tres bicos" with its varied frond shapes (cf. BENL 1969) now and then in the valley of Ginjas (470 m), in the Ribeira de São Jorge (120 m), the Ribeira de Sebastião Vaz (580 m), and even in the south of the island, e.g. below Prazeres (540 m).

After leaving the village of Ribeira Funda and following the ribeira you will see, on both sides of the ravine, many plants of *Cyclosorus dentatus*, *Dryopteris aitoniana* and *Athyrium filix-femina* (L.) Roth, relatively common everywhere in the northern ribeiras, along with a lot of *Polystichum webbianum*. Above 400 m *Pteris serrulata* will be present, of which, sprouting from a rock cleft in the Ribeira de Sebastião Vaz, at 580 m, we had collected a form with long tapering leaf-segments like the one reported from La Palma (cf. BENL & SVENTENIUS 1971: t.2). Then you will enter an untouched jungle of *Diplazium caudatum* forming an amazing ferny scene.

In spite of careful searching we were not lucky enough to meet the bipinnate *Polystichum drepanum* (Sw.) C. Presl, although Reichstein, de Joncheere and Lovis had found it the previous year (1969). Within the past century this second endemic Shield fern, of which LOWE (1851: 523) had seen "abundant wild specimens", seems to have become one of the rarest species, obviously having suffered at the hands of over-zealous collectors.

THE WESTERN REGION OF MADEIRA

One of the principal centres of fern growth in western Madeira is **Rabaçal**, a most attractive landscape with picturesque gorges and waterfalls. The "Casas de Rabaçal" (1065 m) can be reached by a car ride starting from Canhas up to Paúl da Serra (Cova Grande, 1414 m) or more directly from Calheta.

On the slopes behind the different levadas, particularly the "Levada das 25 Fontes" and the "Levada do Risco" there are unexpected extensive stands of *Polystichum falcinellum* (Sw.) C. Presl, the third endemic Shield fern. In general this species is sparingly distributed throughout the island, but near Rabaçal it flourishes in such profusion that it even predominates over the luxuriant *Polystichum setiferum*, the Soft Shield fern. It is not in the least surprising that the hybrid between those two species appears here and we could recognize it by the comparatively soft segments and its abortive spores. It appears to be not identical with *Polystichum maderense* Johnson, the fronds of which are distinctly sub-bipinnatisect (cf. HANSEN 1970: 15-17 t.6). Dr. Lovis also found it and confirmed it cytologically (pers. comm., 1970). *Polystichum falcinellum* with its very rigid pinnae was recorded by previous observers from the roadside between Pico do Poiso and Pico do Arieiro, at about 1450 metres. We furthermore met with it in the Ribeira do Alecrim (1400 m) near the road from Cova Grande to Rabaçal, by the Levada dos Mouros (1280 m, 1350 m) below Bica da Cana, and in the upper course of the Ribeira de João Gômes (850 m)—in a very dry and sunny spot there (cf. BUNBURY 1857: 7, 13).

Another interesting fern along the "Levada do Risco" (1040 m) and beside the footpath to "Furado Novo" (980 m) is *Asplenium anceps* Lowe, here being offered ideal conditions for its establishment. It is similar to the locally more abundant *A. monanthes*, which also grows here, but can be distinguished from it by having several sori per pinna instead of one.—*A. anceps* should be separated from *A. trichomanes* L. subsp. *quadrivalens* D. E. Meyer emend. Lovis, because of its distinctive morphology. In their habit the two taxa are to be distinguished by the relation of length to width of pinnae, in *anceps* being more than twice as long as wide, whereas in *trichomanes* they are of a roundish oblong shape. Besides, the former is recognizable by the three-winged character of its rhachis, and the dark-green shiny upper surface of the pinnae. Considered by some as a variety of *A. trichomanes* it should regain its specific rank.

Asplenium trichomanes subsp. *quadrivalens* was collected by us from walls bordering the highway up to Pico do Serrado (at 970 m) and winding down from there to the remainder of an old volcano, Curral Grande (at 740 m); also between Poiso and Pico do Arieiro. The sites of this spleenwort may become rather dry in summer; *A. anceps* prefers moister substrata and seems to have less tolerance towards dry conditions.

Finally must be mentioned, as a worth-while addition to our findings, a curious form of *Dryopteris pseudomas* with extremely narrow leaf-segments partly bearing unusually large sori.

After a night spent in the resthouse of Rabaçal (belonging to the Junta Geral), you can journey by car, on a rough road, to **Fanal**, a wide plateau with miles of heather, bracken and magnificent old laurel trees decorated by *Davallia canariensis* (L.) Sm. and *Polypodium australe* Fée. From that elevated plain one must turn to the northwest in order to attain the Levada do Fanal, running near the east border of the Ribeira da Janela, well-watered throughout the year and therefore an excellent area for ferns. Here grows *Elaphoglossum paleaceum* (exposed to the north), associated with *Thelypteris limbosperma* (850-1050 m) and *T. pozoi*, *Polystichum setiferum*, *Dryopteris aitoniana* and a lot of *D. aemula*. Also tufts upon tufts of *Hymenophyllum tunbrigense* grow here. After having examined more than a hundred spots in the past four weeks, we finally succeeded in finding (at "Alagoa", 1080 m) *Hymenophyllum wilsonii*, exclusively covering the roots of a *Laurus azorica* and, in close proximity, clothing the surface of a flat rock, mixed with *Hymenophyllum tunbrigense*. It was the highlight of an eventful day! We sent two samples to Dr Lovis the same evening, and were happy to have confirmed that we had discovered the true *wilsonii* in Madeira.

Our *H. wilsonii* is unlike the hybrid (see p. 167). Its colour is a brighter green, the segments of its slender leaves are very distant and little divided (cf. TAYLOR 1960: 90). It is interesting to note that fig. 41 in Hyde, Wade & Harrison "Welsh Ferns" does not match *wilsonii* from Madeira, but the hybrid, which may possibly be more widespread.

THE AREA AROUND FUNCHAL

Funchal, once famous for its many xerophytic ferns growing in the walls of houses, churches and in other dry positions, has become very poor in this respect.

Cheilanthes catanensis (Cosent.) H.P.Fuchs has withdrawn to such inaccessible points as some church towers; some dozens of specimens are yet to be seen upon the tower of São Pedro opposite to the Museu Municipal.

Lowe's "*Cheilanthes maderensis*" [at present *Cheilanthes fragrans* (L.f.) Sw. subsp. *maderensis* (Lowe) Benl] has become extremely rare. After a long search we discovered it in a few spots of the Rua São Roque (210 m) and in a village wall at Trapiche (460 m) north of Pico dos Barcelos.

Cheilanthes marantae (L.) Domin subsp. *subcordata* (Cav.) Benl & Poelt, once known from some ravines north of Funchal, is not a rare fern in Madeira, although far less frequent than in the Canary Islands. Beyond quoted records above Madalena do Mar (copiously!) and in the Ribeira Brava (with leaf lengths of 40 cm and more) we noticed the species (always in its variety *cupripaleacea* Benl, Nova Hedwigia 12: 137, 1966) within the northern coastal district between Faial and Santana. It was growing there in crevices of rock-faces above the road (420-430 m) with fairly opened fronds because of the cooler and moister situation. On the embankments on the opposite side of this highway there is more of this taxon, often in company with *Ceterach aureum* (Cav.) Buch var. *aureum*. The latter, not recognized as a distinct species in Madeira by Vasconcellos (cf. BENL & KUNKEL 1967), was reported by ROMARIZ (1953: 108) in the mountainous countryside north of the capital city ("Espécie rara nos andares inferiores . . . Arredores do Funchal, acima da vila"). It is not infrequent in some ribeiras running to the south coast (extending there up to the west slope of the Ribeira de Santa Luzia e.g. at 500-600 m, and the Ribeira Brava 520 and 630 m), and in roadside walls and gardens in sunny positions (Estreito de Câmara de Lobos 320 m; Trapiche 460 m, 490 m; towards Pico do Serrado, at Ponte Vermelha 970 m, and above 1000 m).

At Trapiche (490 m) plants were found which may be considered an intermediate form between var. *aureum* and var. *parvifolium* Benl & Kunkel (1967: 262).

Pteris vittata L. is still found thriving in walls (mainly of coastal fortresses) within Funchal and in its surroundings. A lovely site of this fern is near Pico da Cruz, where it was present in abundance on a wall of tufa.

As a remarkable fact it may be reported that *Asplenium billotii* F. W. Schultz often prefers surprisingly dry situations in northern suburbs of the capital and outlying parishes as well as farther to the west in the mountains. Very variable in foliage, but distinct in its oblong pinnules coarsely dentate with acute teeth, this species likes to settle there in old walls of cultivated terraces, of gardens and roadsides, always rather sunny yet mostly exposed to the west. We found it especially in São Roque do Funchal, Alegria, Corujeira above Funchal; furthermore at Trapiche and the road towards Pico do Serrado and down from there to Curral das Freiras. From those places we gathered specimens with unusually large leaves (37 × 9 cm) reminding one in their habit partly of the hybrid with *A. onopteris* L. (=*Asplenium* × *joncheerei* D. E. Meyer); but the spores were all perfect. Of course *A. billotii* also extends farther to the west: we found it by the roadside and among other ferns at 1160 m altitude up to Cova Grande.

CLUBMOSSES AND HORSETAILS

When you drive by car from Ribeira Brava to São Vicente, you will cross over the main range stretching across the island by a pass called Boca da Encumeada or simply **Encumeada** (1007 m; see map). Following the levada to the west for about fifteen minutes, you will notice a smaller water-course running out of a low tunnel. It takes you another quarter of an hour going through this tunnel (with the help of a good torch) to come out on the north side of Pico do Cedro, a place which no pteridologist should neglect to visit. Along the narrow canal to the northwest are growing profusely all those beautiful "levada ferns" mentioned above, but in addition you may find in rocky, moderately shady places some specimens of *Huperzia selago* (L.) Bernh. ex Schrank & Mart. in both its atlantic subspecies. At first glimpse these two really distinct taxa are not easy to distinguish, but with a simple pocket-lens you will observe that in one form (subsp. *selago*) the leaves are smooth, whilst in the other they bear up to 50 fine, spiny teeth on their margins. The latter form is now correctly determined as subsp. *dentata* (Herter) Valentine.

Other places where we found the locally scattered subsp. *selago*, were the eastern Encumeada area and a woody slope ("Alagoa") north-west of Fanal (at 1080 m). The spiny-toothed subsp. *dentata* was seen again, together with subsp. *selago*, at 950 m along the magnificent Levada da Serra (= Levada dos Brasileiros) running up the western edge of the Ribeira da Janela and well accessible from Pico da Quebrada (1059 m) above Achadas da Cruz. Further places visited were situated in the rocky Ribeira de Tristão (about 700 m), in the Ribeira de Sebastiao Vaz (600 m, in a laurel wood) and on an eastern slope of the Ribeiro Bonito (550 m), where this impressive clubmoss attains a maximum height of 41 cm!—Both subspecies are confined to mountainous districts.

We cannot confirm that in Madeira the dentate form of the Fir Clubmoss is rarer or more common than the type form, but in the Açores subsp. *dentata* is dominant (ROMARIZ 1953: 71).

As to the nomenclature of this taxon there was some confusion in the latest combinations (cf. PALHINHA & PINTO DA SILVA 1966: 1). ROMARIZ (1953: 71) had named it "*Lycopodium selago* L. ssp. *suberectum* (Lowe) Romariz", supposing LOWE's description of "*Lycopodium suberectum*" (1851: 9) to refer to the spiny-leaved form. However, Lowe's holotype (BM) does not bear leaves with spiny margins; thus "*L. suberectum* Lowe of Madeira and Azores is [only] a luxuriant variety with suberect stems" (BAKER 1887: 9) due to atlantic moisture and subtropical sunshine. HERTER (1909: 31, 41-42) differentiated between "*L. suberectum* Lowe" in Madeira and "*L. dentatum* Hert. n. sp." native to the Açores, not knowing that the latter plant ("margine ca. 50 dentibus longis ornata") occurred in Madeira too. It was only by VASCONCELLOS & FRANCO (1967: 23) that the spiny-leaved plant in Madeira and Herter's "*L. dentatum*" in the Açores were ascertained to be the same taxon. "Consequently" the authors now called it "*Huperzia selago* subsp. *suberecta* (Lowe) Franco & Vasc.", without taking into consideration that Lowe's holotype from Madeira was not identical with Herter's "*L. dentatum*". (Lowe himself did not say one word about spiny leaves in his description of "*suberectum*"!)

Thus for our Madeiran plant only VALENTINE's combination (1964: 44) for the Açorian clubmoss is valid, i.e. "*Huperzia selago* (L.) Bernh. ex Schrank & Mart. subsp. *dentata* (Herter) Valentine".

All the *H. selago* examined by me in Madeira (i.e. 25 specimens) either had leaves toothed throughout, or bore leaves without spiny margins at all. Intermediate forms did not occur in any stage of growth whatever: According to my experience the two taxa are distinctly separated—in Madeira (cf. WARD 1970: 119).

The "extremely rare *Lycopodium complanatum* L." (LOWE 1868: VII)—now known as *Diphasium madeirense* (Wilce) Rothm. and well distinguishable from *Diphasium complanatum* (L.) Rothm. by its flattened lateral leaves which stand out from the stem—seems to be confined to a single habitat: "Frequentemente citado da Encumeada de S. Vicente (cerca de 1000 m), onde se encontra nas fendas das rochas nos locais sombrios." ROMARIZ (1953: 70) and TAVARES (1965: 103) had apparently not seen this clubmoss, but Major C. H. C. Pickering, to whom I owe so much valuable information, told us of a site, where we found about a hundred plants, some of them with their pedunculate strobili, under the shade of *Erica* bushes. — The species is reported also from the Açores.

One of the most attractive points in Eastern Madeira is Portela between Santo da Serra and Porto da Cruz, which commands a spectacular view of the seaside. If you begin walking from here along the western levada you will soon notice the earth walls beyond the canal thickly clad with the locally very abundant Hard fern — at times bearing broad and crenate segments — and enormous masses of *Selaginella kraussiana* (Kunze) A.Br. This plant, extremely rare in the Western Province of the Canary Islands (cf. BENL & SVENTENIUS 1971), is so widely distributed in the misty zone of Madeira, that it is often more dominant than *Selaginella denticulata* (L.) Link and may well be considered indigenous. Both species, often mixed together, can be found in many ribeiras, along most of the levadas, and also on the border of highways.

Two species of horsetails are known to occur in Madeira. *Equisetum telmateia* Ehrh. will be met everywhere in the northern regions. Following the coastal road from Faial to São Vicente you may see it in areas near the mouth of the ribeiras up to 250 metres, in the beds of other streamlets, and in open pastures which are flooded by little springs in summer. Sometimes it will colonise higher elevations: above Cruzinhas (430 m) at the foot of an irrigated rockside, in the Faja de Nogeira (450 m) etc. But we never found a horsetail growing along a levada. It is not so far recorded for Canaries.

The second was only discovered in 1969 by HANSEN (1969: 7), the rare *Equisetum ramosissimum* Desf., which is, however, frequent in Gomera.

CONCLUSION

As regards fern flora and fern vegetation the difference between Madeira and the Canary Islands is evident. What are the reasons for it?

First, the weather is more rainy (precipitation 2000–3000 mm a year in the north) and generally wetter in Madeira ("une humidité extrême", TARDIEU-BLOT 1946: 325). The mist, occasionally hanging down to the coast even in summer and the drizzling clouds in the mountainous interior are an ample compensation for the sunny climate. Xerophytic ferns, therefore, are poorly developed by comparison with their abundance in Canarias, whereas woodland ferns and other species demanding more or less humid conditions vegetate all the year and ripen their spores in summer. Except for *Elaphoglossum paleaceum*, the sporophylls of which were just beginning to unfold in August, we observed soriferous fronds of all taxa cited above.

Beside the climate, Madeira's topography distinctly favours fern vegetation, the interior as a whole being very mountainous. Thus the laurel woods are well protected against destruction by man as a consequence of their natural situation.

Finally the governmental measures and directions for Protection of Nature in Madeira are by far better respected than in the Canaries. (cf. Narciso L. Branco: *A Reserva Natural do "Calderao Verde"*. Lisboa 1968. — F. M. Flores, in *Revta. Agronom.* 27/1: 1-126. Lisboa 1939.)

Visitors too are urgently asked to be careful of the fern vegetation and to preserve the rarer pteridophytes. They ought not to miss a visit to the Preservation Centre of Natural Beauty at Ribeiro Frio (Proteçao da natureza, Parque Florestal), where there is a special collection of most of the indigenous ferns. A visit to Mrs Blandy's marvellous "Quinta do Palheiro" including a superb fernery is recommended.

Our total taxa list was 54. Besides those species mentioned in the text *Pteridium aquilinum* (L.) Kuhn, *Asplenium onopteris* L., *Cystopteris diaphana* (Bory) Blasdell, *C. diaphana* × *fragilis* complex and *Anogramma leptophylla* (L.) Link were seen. Of course one cannot expect to find an *Ophioglossum* in summer. *Asplenium septentrionale* (L.) Hoffm. is extremely rare and is known to grow in only one spot inaccessible to such a degree, that Manuel de Nóbrega, who discovered it in 1951 (ROMARIZ 1953: 103-104), did not succeed in reaching it, in company with J. D. Lovis, 28.7.1969. *Asplenium scolopendrium* L. (= *Phyllitis scolopendrium* (L.)Newm.) occurs somewhere along the Levada dos Mouros; we did not see it, but Mr Pickering knows the hidden place.

The specimens collected by us are housed in the Botanische Staatssammlung München. Duplicates of some species were donated to BM, LJU, Mus.Mun. Funchal, Hb.Poelt and Hb.Reichstein.

ACKNOWLEDGEMENTS

Sincere appreciation is expressed to Prof. T. Reichstein (Basel) and to Dr J. D. Lovis (Leeds) for their most helpful advice and information, and to Mr A. C. Jermy for his thorough revision of the manuscript. Particularly I wish to record my deep sense of gratitude to Major and Mrs C. H. C. Pickering (Funchal) for their constant invaluable assistance, which made our trip (27.7.–30.8.70) so very rewarding.

Sr Eng. Eduardo de Campos Andrada, Chefe da Circunscrição Florestal do Funchal, whose special efforts are directed towards the preservation of the extensive laurel woods with their exceptional richness of ferns, was kind enough to accompany us on our excursion to the Ribeiro Bonito and to procure for us a forestry guide from Cova Grande to the Levada do Fanal and the Levada dos Mouros. He and Mr G. E. Maul (Director of the Museu Municipal do Funchal) placed their respective fern herbaria at my disposal. I am very grateful to both gentlemen.

Last, but not least I am deeply indebted to my wife for her never tiring help in the search for and the preparation of the collected material.

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A COLLECTION OF FERNS FROM ESPIRITU SANTO, NEW HEBRIDES

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INTRODUCTION

The present collection of Pteridophyta was made by one of us (TCC) in August–September 1963, while accompanying Dr R. G. Robbins, who at that time was a Research Fellow at the School of Pacific Studies at the Australian National University and was investigating the structure of the forest communities in this area. The specimens have been identified by ACJ and JAC and this list published in view of the forthcoming Royal Society of London expedition to the New Hebrides.

Collecting, in the northern islands of the New Hebrides, has been very spasmodic and a great many species remain to be recorded. In contrast the southern islands were more thoroughly collected in the 19th century by John MacGillivray, Captain Milne (of HMS Herald), W. R. Guilfoyle (Challenger Expedition) and others, and their scattered specimens are to be found in the major herbaria. Very little material and hardly any fern records are available from the northern islands of the group. In the 1930s they were visited by Kajewski from the Arnold Arboretum and the Oxford Expedition (J. R. Baker and I. Baker). The Oxford Expedition lists give good representation to the angiosperm pantropic strand flora and also to some aspects of the flora of the high ridges (BAKER 1936). For further bibliography see SACHET & FOSBERG 1955, p. 487.

TOPOGRAPHY

The island of Espiritu Santo is made up of two very distinct geological regions which are reflected in the composition and ecological structure of the vegetation. The eastern half of the island is a raised limestone plateau which has a gentle aspect to the north and east. The western half of the island is a rugged faulted mountain chain with signs of very recent fault scarps (not yet colonized by vegetation), suggesting that this is still an area of uplift. The rocks are predominantly submarine volcanic in origin, especially in the west. The sedimentary derivative volcanics to the east merge with the tilted and uplifted limestone plateau. At the head of the Navaka River there is evidence of a dioritic intrusion. The age of volcanics and the limestone is estimated to be Oligocene to lower Miocene.

The whole island of Espiritu Santo is clothed in dense vegetation. The coastal fringe supports the characteristic pan-tropical strand vegetation. From the air the south-eastern forest cover appears reasonably homogenous. The western region supports a mosaic of forest types partly associated with the distinctive topographical conditions.

The soils in the south-east of the limestone plateau vary from almost skeletal on flat areas, to deeper soils in the broad sunken pot-holes. The stature of the vegetation follows this pattern with shrubs covered with vines predominating on the flat areas and tall vine covered forests with a few emergent trees growing from the sink-holes. The impression of the covering on the limestone plateau from a low flying aircraft is of a secondary forest clothed, apart from a few emergent trees, with a dense array of vines and giving the impression of an undulant mass of vegetation. While, undoubtedly, large areas are of secondary nature, it seems possible that much of this vegetation is a mature expression of the rain forest on this limestone topography. The main collecting areas on the eastern half of the island were in the immediate vicinity of Luganville and on stream banks at the Cascades four or five miles inland from Luganville, and also in the remnant forests and the coastal forests of Tangoa Island off the south coast.

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Most of the soils of the western half of the island are formed on deeply weathered rock and probably are as diverse as the mosaic of vegetation which clothes them. Vegetation follows a distinct altitudinal zonation ranging from alluvial buttressed tropical forests on the valley floors to thickets of bamboo and huge emergent species of *Ficus* on the steep slopes and lower ridges; and on ridge knolls (457–762 m) large emergent *Agathis* are present, although not in great numbers. The high ridges, including Pic Santo (1,697 m) are densely covered with moss encrusted trees. The forest is dominated by *Metrosideros collina* and *Melastoma spp.*, the more open ridges are often clothed with ferns and club mosses including thickets of *Gleichenia*, *Sticherus* and *Lycopodium spp.* Considerable patches on the high ridges between Mt. Tabwemasana and the village of Wusi on the west coast have, following repeated disturbances of the habitat, probably by firing and shifting agriculture, become partly dominated by anthropomorphic grasslands similar to those in New Guinea. The collections on the western half were made in the Navaka River valley and the western wall of the upper reaches of this valley and the ridges and high ridges in the vicinity of Pic Santo.

SPECIES COLLECTED BY T. C. CHAMBERS IN 1963

These main localities are referred to in the following list by an initial number only; collector's number (*in italics*) follows the ecological notes.

1 Cascades, 7 km W of Luganville
2 near Luganville
3 old army camp site, Luganville
4 Navaka River valley, up to 750 m
5 track from Navaka River to Pic Santo, 900–1500 m
6 Tangoa Island, off south coast

Lycopodiella cernua (L.) Pic. Ser.

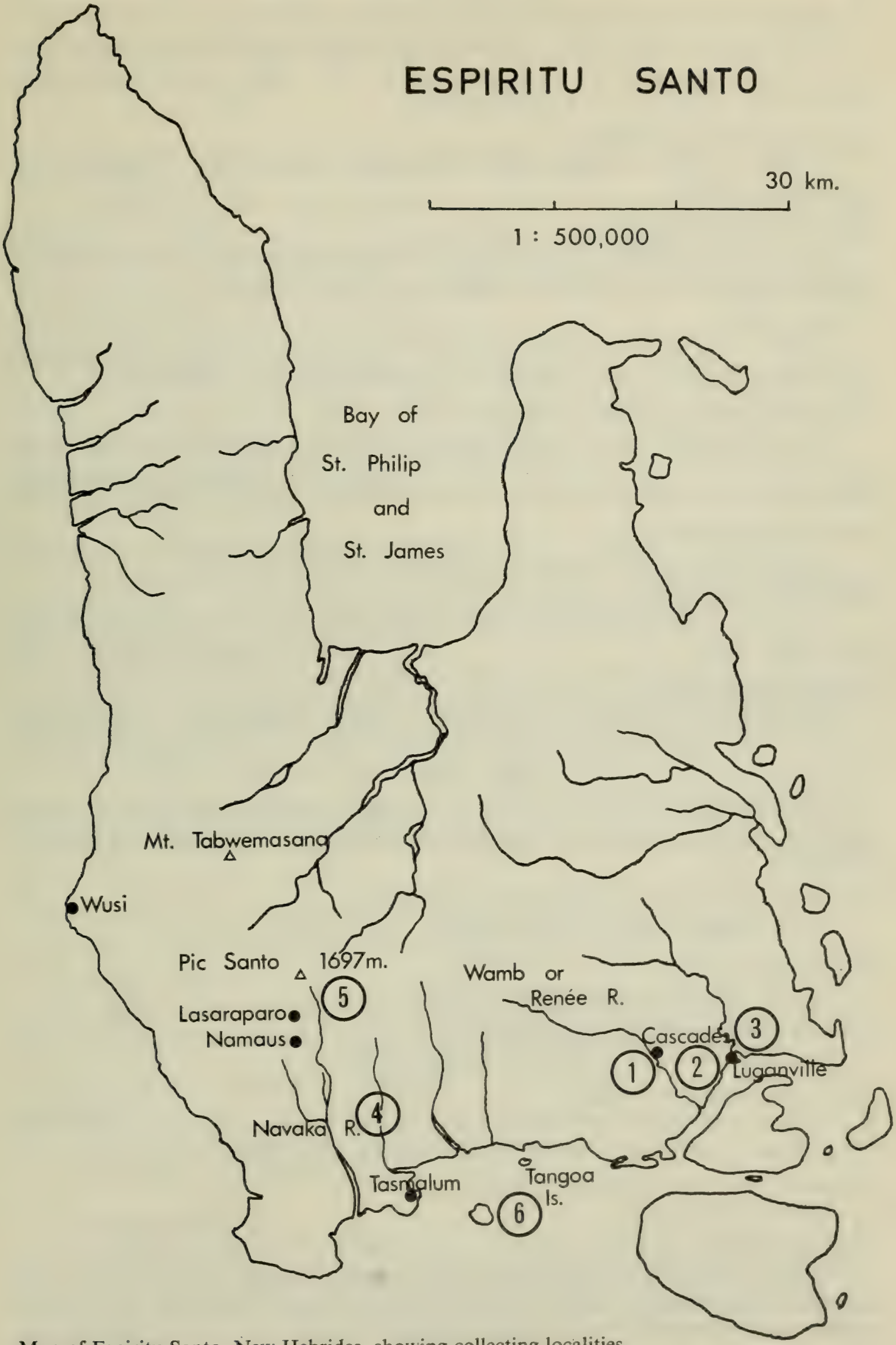
5, associated with *Lycopodium volubile* Forst., on open ridge, *2732.*

Huperzia nummulariifolia (Blume) Jermy ***comb. nov.*** (*Lycopodium nummulariifolium* Blume, Enum. Pl. Jav. *2*: 263; 1828)

4, at 750 m, a rain-forest epiphyte, *2679.* Our specimen is a large-leaved form and sterile. Predominantly a malesian species, but Baker (Handbook Fern Allies: 20; 1887) records it for Erromanga. Specimens from New Ireland and Bewani Mountains of Sepik District, New Guinea are similar to the New Hebridean material.

H. nutans (Brack.) Rothm.

5, epiphyte in forest dominated by *Metrosideros* and *Melastoma*, *2724.*



Map of Espiritu Santo, New Hebrides, showing collecting localities

H. phlegmaria (L.) Rothm.

4, epiphytic on ridge, *2680*. A variable species throughout its range and several pacific island specimens have been given varietal rank. Our specimen agrees with south pacific material more so than malesian.

H. serrata (Thunb.) Rothm.

5, above 1200 m in *Metrosideros-Melastoma* forest, *2730*. Possibly at its southernmost limit.

Selaginella firmuloides Warb.

4, on western slopes at c. 300–600 m, covering large areas of open forest floor, fronds irridescent, *s.n.* Hitherto endemic to New Caledonia.

S. distans Warb.

5, *2735*. The species was described from Fiji and Erromanga. The specimens are transitional to the closely related *S. firmuloides* of New Caledonia.

S. durvillaei (Bory) A. Br. ex Kuhn

1, in sink holes in liane forest in shallow soil, *2655*. Originally described from New Ireland and treated as a variety of *S. caudata* (Desv.) Spring. We can see no difference between our species and *S. victoriae* Moore ex Bull from the SW Pacific.

Ophioglossum pendulum L.

6, epiphytic on various species including coconut palms, *s.n.*

Equisetum debile Roxb.

4, at 30 m on flooded river margins in open valley, *2721*. Nearing its southernmost extent here.

Marattia smithii Mett.

5, at 1500 m on sheltered headwaters of gullies in open forest, fronds up to 5 m tall, *2742*. An extension westwards from Fiji.

Leptopteris wilkesiana (Brack.) Christ

5, near Namous village at c 1200 m in open broadleaf ‘ rain-forest’, often forming a slender trunk 10 cm diam. up to 2 m high, *2727*. From New Caledonia to Samoa.

Gleichenia hirta Bl. var. *candida* (Rosenst.) Holtt.

5, on exposed ridge at 1200 m, *2731*.

Dicranopteris linearis (Burm. f.) Underw.

5, with *Dipteris* on open ridges, *2713*.

Schizaea dichotoma (L.) Smith

4, in lowland forest on alluvial terrace, *2672b*.

Lygodium reticulatum Schkuhr

2, vine forest; Santo melanesian natives call it ‘ Arsersa ’ and use it extensively for binding outriggers, house thatching, bedding, etc., *2649*.

Mecodium imbricatum (Blume) Copel.

5, 1150–1200 m, *s.n.*

M. junghuhnii (v.d. Bosch) Copel

5, *2717*. The specimens collected are distinct in their broad fronds, wide indusia, and stipe and rhachis with an undulated wing. They are very similar morphologically to *M. imbricatum* and grow mixed with it on Erromanga, Although not recorded further east than the Philippines, *M. junghuhnii* may well have a similar distribution to *M. imbricatum.*

M. polyanthos (Sw.) Copel
4, at 750 m, *2693b.*

Reediella humilis (Forst.) Pic. Ser. (*Trichomanes humile* Forst.; *Crepidopteris humilis* (Forst.) Copel.)
1, epiphytic in liane forest, *2659.* 2, epiphytic on trunks of trees in vine forest, *s.n.* 4, c 600 m, *2722a.* All gatherings of this species have wider frond segments than the type (*G. Forster s.n.* BM) and often have two or more indusia on each pinna, rather than the more typical condition of a single indusium acroscopically at the base of each pinna.

Callistopteris apiifolia (Presl) Copel.
5, between first and second villages at c 1125 m, a ground fern in forests subject to frequent mists, *2709.* Distributed from Formosa, Philippines (and Borneo?), Solomon Islands to Aneityum and Fiji.

Macroglena meifolia (Bory) Copel.
5, at c 1500 m, *2726.*

Cephalomanes boryanum (Kunze) v.d. Bosch
1, on the ground in liane forest on limestone, *2663.* We can see no difference between this species and the New Guinea *C. densinervium* Copel.

Selenodesmium elongatum (Cunn.) Copel.
5, between first and second villages in ridge forest, *2702.* An austral species; this specimen is intermediate between the Queensland and New Zealand forms.

Dipteris conjugata Reinw.
5, dominant in patches on open ridges, *2712.*

Histiopteris sinuata (Brack.) J. Sm.
1, in more open sites, the natives call it ‘ wilca ’ and use it for thatching houses, *2665.*

Lindsaea harveyi Carr. ex Seemann
4, *s.n.*; on ground in flat alluvial lowland forest, *2672.*

L. propinqua Hook.
5, ridge forest at 1200 m, *2728.* An extension into the SW Pacific of a species hitherto known from the Marquesas to Fiji (KRAMER 1970).

L. pulchra (Brack.) Carruth. ex Seemann
5, *2719.*

Pteris moluccana Blume
3, on coral limestone, fronds up to 3 m, *2667.*

P. aff. *pacifica* Hieron.
6, ground fern in open coastal vegetation, *s.n.* This has a red-brown stipe but paler than that of material from other pacific islands; likewise it has fewer setaceous hairs on the costae. Another species with which this should be compared is *P. vaupelii* Hieron. of Samoa and of which we have not seen authentic material.

P. vittata L.
3, on limestone, fronds up to 2 m, *2668*.

Acrostichum aureum L.
2, salt-water swamps on coast, *s.n.*

Antrophyum plantagineum (Cav.) Kaulf.
5, *s.n.*

Vittaria cf. *rigida* Kaulf.
5, *s.n.*

Vaginularia subfalcata (Hook.) C. Chr.
4, *2722b*. Our material is not so coriaceous as Hooker's type and has the sorus in the distal third of the frond only. Hooker's illustration in Spec. Fil. 5 (tab. 89 fig. 1) is typical, but figure 2, with a long sorus more than half the length of the frond, is not.

Meniscium beccarianum Ces. (*Cyclosorus beccarianus* (Ces.) Copel.)
5, in forests subject to constant mist and rain, *2710*; on ridge, *2759*. Shortly to be transferred to *Pronephrium* Presl by Dr R. E. Holttum (pers. comm., *Blumea*, in press).

Asplenium falcatum Lam.
5, on ridge in *Metrosideros* forest, epiphytic, *2729*.

A. nidus L.
4, *s.n.*

A. parksii Copel.
1, on stream banks in low light under dense vine forest on uplifted coral limestone, *2654*. Copeland described this species from Rarotonga (Cook Is.); it is possibly related to *A. cuneatum* Lam. Our specimen is distinct in having a single sorus on the acroscopic margin of the pinna, otherwise it compares closely.

A. shuttleworthianum Kunze
4, epiphytic in lower montane forest, *2676*.

A. unilaterale Lam.
1, on limestone-derived soils, under very low light conditions on dark stream-banks in liane forest, *2653*.

Diplazium oblongifolium (Hook.) Jermy ***comb. nov.*** (*Asplenium alternifolium* (Blume) Hook. var. *oblongifolium* Hook., Sp. Fil. **3**: 240; 1860)
1, on banks of uplifted coral in liane forest, *2661*; 5, *2704*. Hooker's type specimen is from Aneityum. This is similar to *D. fraxinifolium* Presl, but the pinnae are sub-cordate at the base and are of a more leathery texture; as in *D. cordifolium* Blume the veins rarely join. It appears to be close to and possibly a continuation of *D. elegans* (J. Sm.) Hook. which ranges from Formosa to the Philippines.

Lunathyrium japonicum (Thunb.) Kurata agg.
5, a very common fern of open montane forest, *2738*. Not typical of the species as seen in E Asia, but has all the characters of *Lunathyrium*, namely creeping rhizome, lamina hairs, verruco-spiny spores, extending the genus into the SW Pacific. Undoubtedly the taxon referred to by KUHN (1869 p. 575) as *Asplenium petersenii* Kunze.

Arcypteris irregularis (Presl) Ching
1, on coral limestone in forest, sterile, *2660.*

Tectaria crenata Cav.
1, on banks of limestone in dense forest, *2664.*

Bolbitis lonchophora (Kunze) C. Chr.
1, ground fern in liane forest, *s.n.*

Elaphoglossum angulatum (Blume) Moore (det. R. E. Holttum)
5, epiphytic in *Metrosideros-Melastoma* ridge forest at 1350 m, *2738b.* Not hitherto known further south than New Guinea.

Blechnum capense s.l.
5, in open ridge forest up to 1200 m, *2675*; Namus village, *2705*; between Namaus village and Pic Santo, *2725.* A complex under revision by one of us (TCC).

B. gibbum (Labill.) Mett.
4, in open ridge forest at 750 m, *2674.* A species restricted so far to New Caledonia and the New Hebrides.

B. norfolkianum (Hew.) C. Chr.
5, south slopes on seepage bank above stream in deep ravine, *2698, 2700, 2711, 2740, 2740a, 2743a-d.* A New Zealand element reaching Samoa.

B. orientale L.
1, in dense liane forest, blade 2–3 m long, *2648.*

B. patersonii (R. Br.) Mett.
5, at 1050–1200 m, *2706, 2707, 2708.*

B. vulcanicum (Blume) Kuhn
5, in open ridge forest at 750 m, *2673, 2691.*

Humata aemula (Mett.) Carr. ex Seemann
Peponssa River valley, Cumberland Peninsula, 1140 m, on moss-covered log in rain-forest, *Robinson s.n.*

H. pusilla (Mett.) Carr. ex Seemann
5, on south slopes at 750 m, epiphyte associated with orchid cushions, *2684.* New Caledonia, New Hebrides to Shortland Is., British Solomon Is. Protectorate.

Oleandra whitmeei Baker
5, climbing on larger trees, *2734.* An extension westward of a Samoan species.

Oleandra neriiformis Cav.
5, *2695.*

Nephrolepis biserrata (Sw.) Schott
1, liane forest on coral limestone, *2652.*

Microsorium irioides (Poir.) Fée
4, *s.n.*

Selliguea feeoides Copel.
5, epiphytic, *2720.*

Drynaria rigidula (Sw.) Bedd.
6, epiphytic on many species, fronds pendulous, *s.n.*

Calymmodon cucullatus (Nees & Blume) Presl
5, *2718*.

Ctenopteris contigua (Forst.) Holtt.
4, in lowland alluvial forest, but common as epiphyte or lithophyte from sea-level to Pic Santo, 2000 m, *2678*; 5, in moss cushions, *2696*. Peponssa River valley, Cumberland Peninsula, 1140 m, on moss-covered log in rain-forest, *Robinson s.n.*

ACKNOWLEDGEMENTS

A grant from the Australian CSIRO, Science and Industries Endowment Fund contributed towards the cost of travel (TCC) to the New Hebrides. Collecting and processing this material would not have been possible without the assistance of Mr R. J. S. Hutchinson, British District Agent, Dr and Mrs Gilbert Jones, Geologists, Mrs Mary Fung Kwun Chee, Fran Hed (Native Police Boy), the Reverend and Mrs Paddy Jensen of the Presbyterian Teachers Training College, Tangoa Island, and Mr and Mrs Fred Stevens, Planters at Tasmalum, and a willing group of six native carriers recruited at Ipiata village, and the Chief of the mountain village of Lasaraparo (" New Place " or Ellapaimatse) who made a house available.

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FURTHER CYTOLOGICAL AND TAXONOMIC OBSERVATIONS ON SOME MEMBERS OF THE *CYCLOSORUS PARASITICUS* COMPLEX

J. GHATAK* and I. MANTON*

WITH A NOTE ON THE NOMENCLATURE OF THE TAXA INVOLVED

BY R. E. HOLTTUM**

ABSTRACT

Evidence is presented from synthesized hybrids indicating that diploids with erect rhizomes in four different geographical areas known under three different names are in fact no more than geographical variants of one species, the correct name for which appears to be *C. quadrangularis* (Fée) Tard.

Similar evidence indicates that *C. subpubescens* sensu Holttum 1954 is conspecific with *C. dentatus* (Forsk.) Ching from other areas (notably Ghana, Madeira and Jamaica).

Hybrids between *C. dentatus* (including *C. subpubescens* sensu Holttum) and *C. parasiticus* (L.) Farw. from Ceylon show an unexpectedly high pairing capacity, indicating the need for further information on the possibility of autopolyploidy in the ancestry of one if not both of these taxa.

INTRODUCTION

The following observations are placed on record mainly because they show that an experimental approach can sometimes reduce the number of taxa in need of recognition at the species level, although the converse experience is more usual. The hybrids involved were set up some years ago (1957-8) as part of the requirements for the degree of Ph.D. by one of us (GHATAK 1959) and they represent an incomplete investigation which cannot be continued by the present authors in any foreseeable future. We are able however to pinpoint certain outstanding problems which, with a little further work of a different kind, could almost certainly be resolved and, if this were done, some interesting general conclusions should emerge which would complement the more limited conclusions introduced here.

There is nothing worthy of comment about the methods, which are substantially as described by MANTON (1950) for the cytology and by LOVIS (1968) for the hybridization techniques. Essential information about the initial wild material will be included here as required though most of the specimens involved have already entered in one way or another into previous publications, notably MANTON & SLEDGE (1954) for the Ceylon specimens, MANTON in HOLTTUM (1954) for Malayan specimens, MANTON in ALSTON (1959) for African specimens and PANIGRAPHI & MANTON (1958) for some preliminary experimental results which showed for the first time that work of this kind could be carried out with tropical ferns.

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PART I. THE SPECIFIC IDENTITY OF DIPLOIDS WITH ERECT RHIZOME FROM CEYLON, BORNEO, GHANA AND NIGERIA

The material assembled under this head consisted of four different wild gatherings, each a single adult plant sent alive to Kew and cultivated further there. Spores from these plants were subsequently sown in Leeds to provide the prothalli used in the hybridization programme. Details are given below.

LIST OF DIPLOID SPECIMENS WITH ERECT RHIZOME USED IN THE INVESTIGATION*

1. *C. repandulus*, Ceylon (P90, coll. I. Manton 1950), ref. Manton & Sledge 1954, Panigrahi & Manton 1958.
2. *C. contiguus*, Sarawak, Borneo. (Kew ref. 335.58) coll. R. E. Holttum 1958.
3. *C. quadrangularis* (pigmented form), Ghana, F.19 coll. C. D. Adams 1956.
4. *C. quadrangularis* (non-pigmented form), Nigeria, coll. between 1956 and 1957, other details unknown.

It should be noted, with respect to specimen 1, that the question of naming had been discussed in some detail by Panigrahi & Manton 1958 who were already aware of the fact that the Ceylon material of this diploid should probably have been referred to *C. contiguus* (Rosenst.) Copel. instead of *C. repandulus* (v.A.v.R.) Ching although, as a temporary expedient, the latter name was retained for the experimental work since it had already been applied to the same specimen (P90) in MANTON & SLEDGE (1954). In order to explore the specific identity further an authentic example of *C. contiguus* was personally gathered in Borneo (specimen 2) by Professor R. E. Holttum at the request of the senior author and identified according to the usage of HOLTTUM (1954).

Specimens 3 and 4 on the other hand were obtained in connection with an entirely different project, namely that of providing a cytological appendix to a flora of west tropical Africa then in preparation. The two specimens, sent in by correspondents, had been named as *C. quadrangularis* (Fée) Tard. by A. H. G. Alston before his untimely death prevented further discussion. The flora, containing the statement that these two specimens were diploid, subsequently appeared posthumously (ALSTON 1959).

Morphologically all these plants could be readily distinguished from each other by individual characteristics which at first gave us no reason to doubt that we were dealing with separate species. Thus plant 3, the first of the African diploids, is extremely conspicuous on account of a purple anthocyanin pigment present on its stipe and rhachis. In Alston's view this character was not sufficient to justify specific separation of non-pigmented African forms, one of which from Nigeria (Specimen 4) had been collected explicitly to test this. Attention was however drawn to the presence of a hairy indusium on the Nigerian material which was absent from the others. Similarly the Ceylon material (Specimen 1) was easily distinguished by the exceptionally long hairs (1 mm instead of 0.5 mm) on the rhachis and stipes.

Nevertheless as the hybridization programme developed, the similarity of behaviour of all four diploid cytotypes when crossed with some of the same tetraploid individuals previously used by Panigrahi & Manton drew attention to the need for closer scrutiny of specific boundaries among the four diploids. A new hybridization programme at the diploid level was therefore undertaken to test directly, if possible, the number of genomically different diploids represented in our collection. To do this it was necessary to find some genetic marker which would attest the correctness of a putative hybrid by effectively distinguishing it from accidentally produced homozygotes (for discussion of this danger see PANIGRAHI & MANTON (1958). Fortunately the anthocyanin pigment in plant 3 provided exactly the character needed. The dominance of anthocyanin versus its absence had already been demonstrated with pigmented tetraploids when crossed with our non-pigmented plant 1 by Panigrahi & Manton and similar behaviour would be expected at the diploid level. By using plant 3 as a source of spermatozoids an immediate recognition of a heterozygote as such would be expected, and was indeed found, in crosses involving non-pigmented forms used as females.

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*A map indicating the old world distribution of these diploids with a preliminary communication of the present observations will be found in Manton 1961.

Hybrids between plant 3 and each of the other diploids were set up and attested in this way. All were fully fertile and gave regular chromosome pairing at meiosis. It seems probable therefore that all may, in fact, represent no more than geographical variants of a single species.

PART II. MUTUAL AFFINITIES AMONG TETRAPLOIDS: C. DENTATUS, C. SUBPUBESCENS SENSU HOLTTUM AND C. PARASITICUS

Reduction of the number of diploids to a single genome where at least two had been hoped for greatly increases the difficulty of genome analysis of the available tetraploids and it will therefore be necessary to limit discussion of the hybrids which had been raised before these facts were ascertained to no more than a selected few. The more important tetraploids used as sources of spores for raising prothalli are listed below. Except where otherwise stated each was initially a single specimen gathered wild and subsequently maintained in culture in Leeds or at Kew.

LIST OF THE MORE IMPORTANT TETRAPLOIDS USED AS PARENTS OF HYBRIDS

5. *C. dentatus* Madeira coll. I. Manton 1950 ref. Panigrahi & Manton 1958.
6. *C. dentatus* Ghana coll. C. D. Adams ref. Manton in Alston 1959.
7. *C. dentatus* Jamaica coll. T. G. Walker ref. Walker 1967.
8. *C. subpubescens* sensu Holttum 1954 Singapore ref. Panigrahi & Manton 1958.
9. *C. parasiticus* Ceylon P92 and P885 coll. I. Manton 1950 ref. Panigrahi & Manton 1958.

Some difficulty had been experienced by PANIGRAPHI & MANTON (1958) in compiling a table of characters permitting easy separation of items 5 and 8, which seemed more alike when expressed in this way than their superficial appearance alive had suggested. Two characters, notably hair length and spore size could be used to do this (*loc. cit.* p. 734) and a few others have been detected since; notably spore patterning and minor differences in the distribution of hairs between the veins on the upper surface of the lamina. The arrival of other gatherings of *C.*

dentatus from different geographical areas, notably Ghana and Jamaica (specimens 6 and 7) nevertheless introduced complications. Minor differences could be found to distinguish each and all of these gatherings, whilst certain other differences, notably in hybridizing potential, seemed greater between certain of these gatherings than between some of these and *C. subpubescens* sensu Holttum. The need for direct evidence on the existence or otherwise of specific boundaries between these supposedly distinct taxa seemed therefore as important as in the comparable case of the four diploids discussed in the previous section.

A suitable genetical marker to attest the correctness of crosses between the various tetraploids was more difficult to find than among the diploids since all the tetraploids possessed anthocyanin pigment to some extent and this character could not therefore be used. However the spore patterning which distinguishes *C. subpubescens* sensu Holttum from the various gatherings of *C. dentatus* seemed a reliable character. The differences are illustrated in Plate XIX A and C beside an example of a hybrid (Plate XIX B) indicating recessive behaviour of the verrucose pattern of *C. subpubescens*. By using the latter as female, recognition of true heterozygotes among the progeny obtained from inseminations with *C. dentatus* spermatozoids seemed possible.

Hybrids authenticated in this way between *C. subpubescens* and *C. dentatus* from both Ghana and Jamaica were fully fertile, as the appearance of their spores indicates, and gave regular chromosome pairing at meiosis. We therefore think it virtually certain that *C. subpubescens* sensu Holttum is not specifically distinct from *C. dentatus*.

In contrast, some other tetraploid hybrids involving *C. parasiticus* (L.) Farw. notably *C. subpubescens* (Singapore) × *C. parasiticus* (Ceylon) and *C. parasiticus* (Ceylon) × *C. dentatus* (Jamaica) produced the mixture of mis-shapen spores to be expected in genuinely interspecific hybrids. These therefore serve as a valuable foil to the preceding since they show that specific barriers, when present, can be expressed and detected in this way.

PART III. NOTES ON THE CYTOLOGY AT MEIOSIS IN THE HYBRIDS

This topic needs no further discussion with respect to the intraspecific hybrids though the summary provided in Table 1 may perhaps prove useful for other purposes. On the other hand the *inter* specific hybrids mentioned above and

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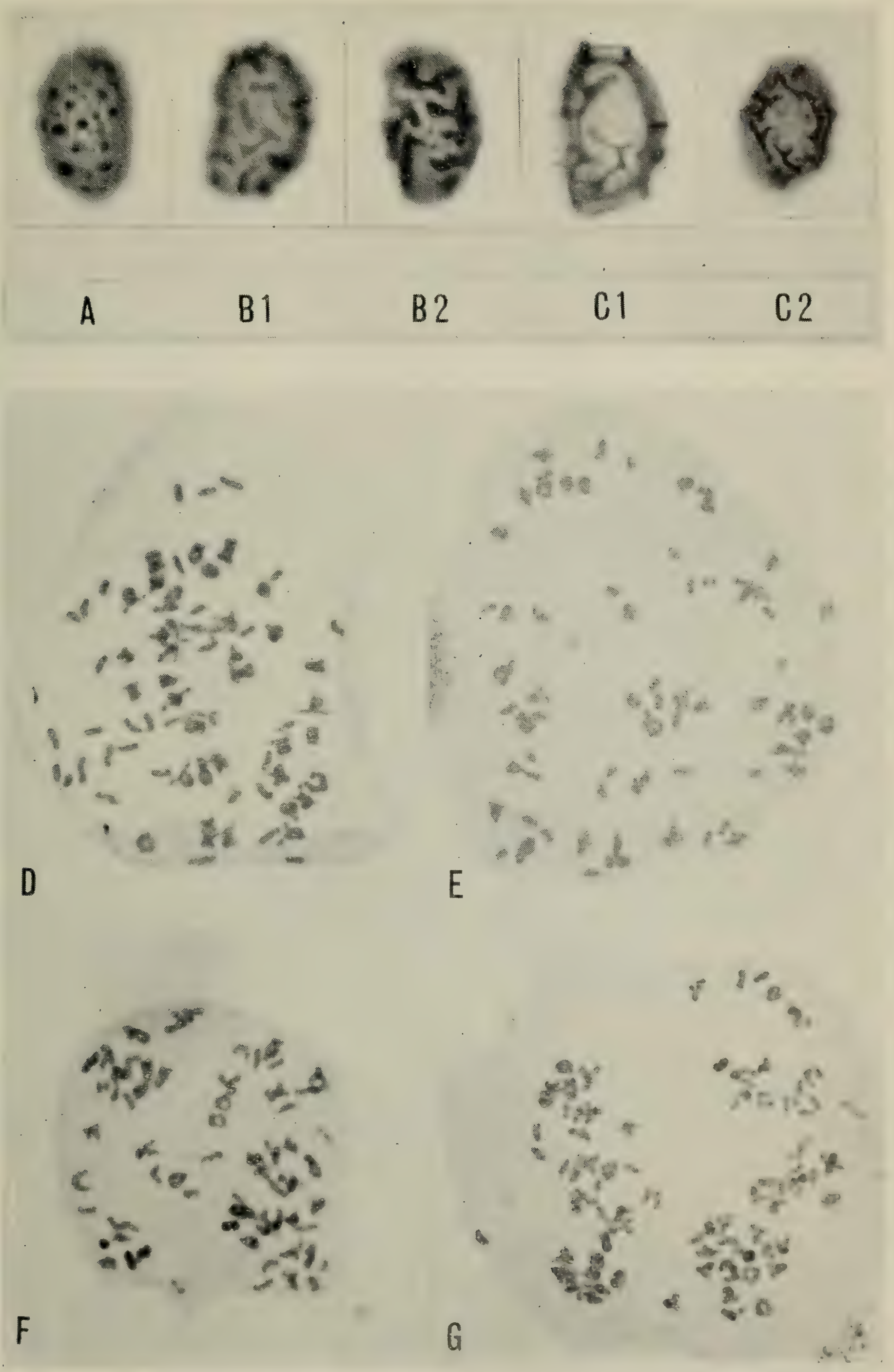
PLATE XIX. **A:** spore of *C. subpubescens* sensu Holttum (Singapore) × 1000; **B:** spores from hybrids × 1000: **B1**: *C. subpubescens* × *dentatus* (Jamaica); **B2**: *C. subpubescens* × *dentatus* (Ghana); **C:** spores of *C. dentatus* × 1000; **C1:** Jamaica; **C2:** Ghana. **D:** meiosis in a triploid hybrid: the Ceylon diploid (P90) × *C. dentatus* (Madeira) synthesised by Panigrahi and recorded in Manton & Panigrahi 1958 but reinvestigated when the plant was three years older and fully mature; the pairing is approximately 36 pairs and 36 univalents × 1000; **E:** meiosis in a triploid hybrid: *C. quadrangularis* pigmented form (Ghana) × *C. parasiticus* (Ceylon), plant Gh. 88F7, showing approximately 36 paired groups some of which could be trivalent, the remaining chromosome univalent. × 1000; **F:** meiosis in a triploid hybrid: *C. quadrangularis* pigmented form (Ghana) × *C. dentatus* (Ghana), plant Gh. 64 C, showing approximately 36 pairs and 36 univalents. × 1000; **G:** meiosis in a tetraploid hybrid: *C. parasiticus* (Ceylon) × *C. dentatus* (Jamaica), plant Gh. 204 C, showing more than 36 paired groups plus univalents. × 1000.


A
B1
B2
C1
C2
D
E
F
G

further enumerated in Table 2 will be dealt with only in outline since the facts are not fully interpretable without some additional information which we do not at present possess. Certain general features nevertheless stand out and are illustrated in the plate.

TABLE 1

Numerical details of intraspecific crosses, the female parent of the hybrid being in each case given first (for fuller citations see lists pp. 184, 185).

	Yield*	**Plants analysed**	**Cells analysed**	**Chromosome pairing**
Diploid				
P90 (Ceylon) × F19 (Ghana)	2/58	2	10	36 pairs
Nigeria × F19 (Ghana)	2/25	1	4	36 ,,
Borneo × F19 (Ghana)	4/30	1	3	36 ,,
Tetraploid				
subpubescens × *dentatus* (Ghana)	6/28	6	20	72 pairs
dentatus (Ghana) × *subpubescens*	1/16	1	8	72 ,,
subpubescens × *dentatus* (Jamaica)	2/15	1	4	72 ,,

*Expressed as a fraction in which the numerator represents authenticated hybrids and the denominator the number of prothalli used.

TABLE 2

Numerical details of hybrids giving approximately 36 or more pairs together with univalents; the female parent in each case given first.

	Yield*	**Chromosome pairing**
Triploids		
P90 (Ceylon) × *C. dentatus* (Jamaica)	—	pairs (c.36 ± 2) + univalents
P90 (Ceylon) × *C. dentatus* (Madeira)	—	pairs (c.36) + univalents (Pl. XIXD)
F19 (Ghana) × *C. parasiticus*	—	pairs (c.36 trivalents not excluded) + univalents (Pl. XIXE)
F19 (Ghana) × *C. dentatus* (Ghana)	2/34	pairs (c.36) + univalents (Pl. XIXF)
Nigeria × *C. subpubescens*	2/47	pairs (c.36 ± 2) + univalents
Nigeria × *C. parasiticus*	4/32	pairs + univalents
Borneo × *C. parasiticus*	3/28	pairs (c.36 ± 6) + univalents
Borneo × *C. dentatus*	3/31	pairs + univalents
Tetraploids		
C. parasiticus × *C. dentatus* (Jamaica)	—	analysis difficult but not less than 48–54
C. subpubescens × *C. parasiticus* (P285)	—	paired groups plus some univalents.

*When known expressed as a fraction in which the numerator represents authenticated hybrids and the denominator the number of prothalli inseminated.

It is clear that all the interspecific hybrids form pairs and univalents in considerable numbers although completely analysable cells are rare, and for certain combinations have not as yet been attained. If we consider the triploids first (Pl. XIX D-F) there is no doubt that all are able to form pairs or paired groups in a reasonably close approximation to the monoploid number ($x=36$). This is true even in hybrids which, on the information contained in PANIGRAHI & MANTON

1958, had been expected to show substantially reduced pairing. It will be recalled that these authors reported little or no pairing in three hybrids between the Ceylon diploid and *C. dentatus* from Madeira although the same diploid crossed with *C. subpubescens* sensu Holttum formed approximately 36 pairs and 36 univalents (*loc. cit.*) However one of Panigrahi's own plants, re-investigated 3 years later, gave the preparation illustrated in Pl. XIX D and we have resynthesised the same hybrid combination ourselves without being able to repeat their previous result. It must be assumed therefore that some fortuitous but temporary circumstance had adversely affected meiosis in one particular batch of young hybrids (1½ years old when first investigated in 1954) which ceased to operate as these plants became more mature. It therefore seems virtually certain that, pathological accidents apart, there is no ascertainable difference in the pairing behaviour of hybrids involving *C. dentatus* (Madeira) compared with equivalent hybrids (e.g. Pl. XIX F) involving other strains of the same taxon (including *C. subpubescens* sensu Holttum). On the other hand certain triploids involving *C. parasiticus* in exceptionally favourable preparations (e.g. Pl. XIX E) can strongly suggest the presence of trivalents replacing some pairs. The validity of these appearances will need confirmation but it is fair to say that trivalent production in some of these hybrids has not been wholly excluded by our observations.

The pairing behaviour of tetraploid hybrids between *C. dentatus* (including *C. subpubescens*) and *C. parasiticus* is more difficult to analyse and we have no cells as yet in which this can be completely carried out. Pl. XIX G nevertheless illustrates sufficiently a fact to which we attribute considerable significance namely that in spite of a very low spore output and the invariable presence of some univalents the pairing potential in such hybrids is by no means low. Approximate counts of minimum numbers of pairs or paired groups in a range of cells vary from 48 to 54. There is no doubt therefore that such hybrids can form more than 36 paired groups.

This observation at once raises the possibility, which might be confirmed or refuted but which cannot be ignored, namely that one if not both of these two tetraploid species might have had an autopolyploid ancestor. This is therefore the point at which further experimental work is still required.

DISCUSSION

Readers of this journal will be well aware of the fact that one of the more important recent advances in fern cytology, carried out since the publication of MANTON (1950) and indeed since MANTON (1961), has been the unequivocal demonstration of the reality of autopolyploidy as a factor involved in fern speciation in addition to the more familiar and much more easily demonstrated allopolyploidy. This new development rested at first mainly on the observations carried out independently by VIDA (1963), Lovis & Reichstein (in LOVIS, 1964) and SLEEP (1966) on European species of *Asplenium*. Among tropical ferns analysed in this way the interspecific hybrids between *Adiantum incisum* of Africa and *Adiantum malesianum* of Malaya and South China (MANTON, SINHA & VIDA, 1970) show a suggestive resemblance to the *Cyclosorus dentatus* × *C. parasiticus* hybrids investigated here, allowance being made for a difference in "*x*", the monoploid chromosome number. The *Adiantum* analysis (further summarized in MANTON *et alia*, 1970) was more completely worked out than that of *Cyclosorus* owing to the fortunate availability of a greater number of differentiated taxa. These included two different diploids and at least two undoubted allotetraploids, with the aid of which clear evidence for an essentially autopolyploid origin for *A. incisum* Forsk. of Africa could be provided. As in other cases, this autopolyploid had become fully diploidized in the present wild species by the suppression of multivalent formation, presumably by genetical means under the influence of natural selection. In hybrids, however, a minimum of "*x*" pairs was invariably introduced, by autosyndesis within the *A. incisum* genome, no matter whether the other taxon involved in a hybrid was closely related or not.

It is obvious that seriously erroneous conclusions would be reached if autosyndetic capacity were present, but unrecognised, in polyploids used as part of a hybridization programme. The problem of recognition can nevertheless be resolved in more than one way. The most direct and, if it could be done, the quickest way to do this in the case of *Cyclosorus* would be if apogamy could be induced and the resulting "haploid" sporophytes raised to maturity. Meiotic behaviour in these would at once reveal the true composition of the normal gametophytic chromosome complement. Thus a descendant of an autopolyploid tested in this way should still show regular pairing. The equivalent from an allopolyploid (amphidiploid) should show complete failure of chromosome pairing. Various intermediate conditions are also possible. An answer to the phyletic problem raised by *C. parasiticus* and *C. dentatus* is thus by no means unattainable and an immediate clarification of cognate aspects of a fairly complicated biosystematic situation would at once be introduced if such work could be carried out.

Finally, the nomenclatural problems raised by parts 1 and 2 of the present communication require expert taxonomic attention for which we are fortunate in being able to draw on Professor Holttum. He is currently engaged on a comprehensive taxonomic and nomenclatural revision of the group and has most kindly compiled the following statement with permission to include it here.

NOTES* ON THE NOMENCLATURE OF THE TAXA INVOLVED IN THE BIOSYSTEMATIC ENQUIRY

The Diploid Species

The name *Nephrodium quadrangulare* was given by Fée in 1852 (Gen. Fil. 308) to a specimen from French Guiana. His description does not mention characters now found to be important diagnostically. Hooker failed to mention Fée's name in his *Species Filicum*. Christensen, in *Index Filicum* (1905) printed it in italics, as of doubtful significance. In part 1 of his monograph on *Dryopteris* in America (which included all Thelypteridaceae) he placed it without comment as a synonym of *Dryopteris mollis* (Jacq.) Hieron., a name which he then interpreted very broadly, and which he later (1920) placed, in this broad sense, as a synonym of *D. dentata* (Forsk.) C. Chr. Alston was the first person to point out distinctions between Fée's species and *D. dentata*, in an account of the ferns of St. Kitts (Journ. Bot. **75**: 253; 1937), remarking also that plants similar to *D. quadrangularis* occurred in Africa. In Asia, ferns of this alliance were usually given the specific epithet *mollis*, widely interpreted, or later *parasitica*. In 1917 Rosenstock briefly described a specimen from Borneo in the Rijksherbarium Leiden, with the name *Dryopteris contigua*, but without giving some important details. Christensen discovered the specimen and gave a fuller description of it (Gard. Bull. Str. Settl. 7: 244; 1934) in his account of the ferns of Mt Kinabalu; he mentioned the erect caudex. Similar plants were found during the Leeds University expedition to Ceylon (1950-51), brought into cultivation at Leeds and Kew, and their diploid nature established; they were identified as *Dryopteris repandula* v.A.v.R., a name published in 1924 and based on a specimen from New Guinea, seen by Panigrahi in the Leiden herbarium. In my opinion, there is some doubt whether the type specimen of *D. repandula* is conspecific with that of *D. contigua*; from a nomenclatural point of view, this in unimportant as *contigua* was published first. During further work on the cytology of African ferns, plants named *quadrangularis* from Nigeria and Ghana were brought into cultivation; they showed only minor differences from the Ceylon plants and were also diploids. Finally, I sent plants from Sarawak to Kew which proved to be typical *contigua*, and diploid; they differed from the Ceylon plants in minor characters of pubescence (e.g. presence of short capitate hairs on the upper surface).

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*Contributed by R. E. Holttum.

Recently Dr Alan R. Smith of the University of California has made a study of plants believed to represent this species in America. His statement (personal communication with permission to quote) runs as follows: "I have counted the plant previously known as *Thelypteris versicolor* from 9 localities in Florida and Louisiana. In all cases it was diploid. As a result of my monograph of the New World species, I am treating *versicolor* as a variety of *quadrangularis*. — — I have not counted the varieties of *quadrangularis* from the West Indies and South America, but I would be surprised if they are anything other than n=36. I found a good correlation in the group between spore size and ploidy level, and the spores of varieties of *T. quadrangularis* outside the U.S. were identical in size and ornamentation to spores of *versicolor*."*

Thus I have no doubt that all these ferns (with the possible exception of *D. repandula*) represent one species, with minor local differences, in tropical America, Africa, Ceylon and Malesia (I have seen no herbarium specimens among the many I have examined from India). The slow realisation of this situation is due to the fact that students of the flora of one part of the tropics have in the past rarely had at their disposal adequate information about possibly allied species in other parts; and even Christensen, the pioneer of modern study of this family of ferns, failed to think about the West Indies when studying specimens from Borneo. It was only the stimulus to comparative study provided by Professor Manton's work on cytology, together with the fortunate fact that co-operation was simultaneously available from various parts of the tropics, that made the present synthesis of information possible. Summarising: in my view the specific epithet *quadrangularis* is the correct one to use for all these diploids, *contiguus* being discarded as a later synonym.

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*Since completion of this manuscript an additional plant of *C. quadrangularis* collected on Ascension Island (Conder Cliff, 2,750 ft) was kindly supplied by A. C. Hill of Cambridge. Chromosome counts made on young sori in the autumn of 1970 and again in the spring of 1971 are diploid (n=36). This observation thus bridges the geographical gap between the African material recorded in the text and the American material referred to in the taxonomic notes. (I.M. June 1971.)

The Tetraploid Species

In the 19th century the specific epithet *mollis* (originally applied by Jacquin to a specimen from Venezuela) was used for a complex of forms, found widely throughout the tropics. In India, Beddome and others attempted to distinguish varieties, or distinct species, but the situation remained confused. In *Synopsis Filicum* (1867) Baker stated that he believed the name *Polypodium parasiticum* L. was applicable to the same complex, but he did not formally adopt the name. The binomial *Dryopteris parasitica*, based on Linnaeus, was published by Otto Kuntze in 1891 and adopted by Christensen in his *Index* of 1905, with Jacquin's name as synonym. In 1912 Christensen discovered a Linnaean specimen (found by Osbeck in China) of *P. parasiticum*, in the herbarium of Swartz at Stockholm, and published a description, distinguishing it from the West Indian *mollis*. Then in 1920 he published his discovery that the type specimen of *Polypodium dentatum* Forskal (1775), from Arabia, was not specifically distinct from typical *mollis*. Christensen continued to collect information on this species-group, and this was first used in a conspectus of species of China and India by Ching (Bull. Fan Mem. Inst. Biol., Bot. Ser., **8**: 157-230; 1938). Ching transferred the species group to *Cyclosorus*, and distinguished between *parasiticus* and *dentatus*; he also distinguished other allied species clearly for the first time. In my own study of Malayan ferns at Singapore, I corresponded with Christensen, who called my attention to the name *Aspidium subpubescens* Bl., which he thought should replace *latipinna* Hook. (Gard. Bull. Str. Settl. **4**: 390; 1929), and it was adopted in this sense by Ching (with *jaculosus* Chr. also as a synonym) in 1938. But I later had on loan from Leiden a specimen labelled *subpubescens* from Blume's herbarium, and found it to correspond with a common Singapore fern, not with *latipinna*. I therefore used Blume's name in that sense in my book on the ferns of Malaya (1954). It was only later that I discovered that my *subpubescens* did not differ significantly from *dentatus*. I also noticed a distinct but related fern in Singapore and adopted for it (I believe correctly) the name *sumatranus* (v.A.v.R.). Professor Manton had plants of both my *subpubescens* and *sumatranus* from Singapore, and they were used in the experimental work reported by Panigrahi and Manton (1958). In April 1970 I visited Leiden and there examined all available specimens labelled *subpubescens* by Blume. In *Enumeratio Plantarum Javae* (1828, p. 149) Blume described this species and then briefly var.B, var.C, and var.D, with localities of origin for each. After examining all specimens I could find, and comparing them with the information in Blume's book, it seemed to me clear that the description of the species proper (as distinct from the varieties) was prepared from a specimen on a double-size sheet which I had not previously seen. This specimen corresponded with *sumatranus* as described by me in my book. My conclusion then is that *C. subpubescens* of my book (not of Blume) is a synonym of *C. dentatus* (Forsk.) Ching, a species found throughout the tropics and I therefore agree with Ghatak and Manton with respect to this taxon. *C. sumatranus* of my book on the other hand is a synonym of the true *C. subpubescens* (Bl.) Ching (but not in Ching's sense), a species of the Malayan region the exact distribution of which is at present uncertain.

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BRIT. FERN GAZ. 10 (4) 1971

CYTOLOGY OF SOME FERNS OF KATHMANDU VALLEY

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ABSTRACT

A collection of 53 species of ferns occurring in the Kathmandu valley of Nepal has been made of which 40 have been cytologically investigated. The counts for some of the species have been made for the first time. Cytological study of the ferns of the region between the eastern and western Himalayas gives an idea of the gradual reduction in the occurrence of polyploids. The data have been compared with those existing for other comparable regions.

INTRODUCTION

The Kathmandu valley of Nepal covers an area of 565 square km and lies at an altitude of 1350 m surrounded by high mountains in the Himalayas. The valley has a moderately humid temperate climate of the monsoon type. While the cytology of the ferns growing in both eastern and western Himalayas has been worked on by various workers, the ferns of the central Himalayas still remain cytologically unexplored although a list of 60 taxa which occur in this valley has been published (PANDE 1962). In the present paper the cytology of forty species occurring wild in the region is reported, some of the counts being made for the first time.

MATERIALS AND METHODS

The localities from which the collections were made are given below. Cytological preparations were made following techniques already standard for ferns (MANTON 1950). Herbarium specimens of the cytologically investigated taxa have been deposited in the herbarium of the Department of Botany, Patna University and one specimen of each has been also deposited in the herbarium of the Royal Botanic Gardens, Kew.

The chromosome numbers for the different species were determined from a number of dividing cells. Photographs of some of the preparations are given in Plates XX and XXI (facing page 198 and 199). The order of the genera follows that of COPELAND (1947).

OBSERVATIONS

The cytological results have been assembled in tabular form with details of localities, ploidy etc. Further details have been discussed separately for selected taxa.

List of cytological findings for the taxa investigated

(One asterisk denotes a new record, no asterisk means that the record agrees with existing records from elsewhere. Two asterisks denote an illustration in the Plates).

n=meiotic count from S.M.C.; $2n$=mitotic count from root-tip.

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Species	**Locality**	**Ploidy**	**Chromosome number**	
			n	**2n**
GLEICHENIACEAE				
Dicranopteris linearis (Burm.) Underw.	Pharping	Diploid	—	78**
PTERIDACEAE				
Dennstaedtia appendiculata (Wall.) J.Sm.	Chandragiri	Tetraploid	60	120
Microlepia firma Mett.	Swayambhu hill	Tetraploid	—	172*
Hypolepis punctata (Thunb.) Mett.	Thankot	Tetraploid	104**	—
Pteridium aquilinum var. *wightianum* (Ag.) Tryon	Swayambhu hill	Diploid	52	104
Pteris cretica L.	Thankot	Diploid	29	58
Pteris vittata L. (*P. longifolia* sensu Beddome)	Thankot	Tetraploid	58	116
Pteris quadriaurita Retz.	Kirtipur Chapagaon Ichangu	Triploid (apog.)	87	87**
P. tripartita Sw.	Chandragiri	Diploid	29*	58*
Coniogramme caudata (Wall.) Ching	Swayambhu hill	Tetraploid	60*	120*
Cheilanthes farinosa sensu Blanford	Tri Chandra College campus	Diploid	30	60
Onychium japonicum var. *lucidum* (Don) Christ.	Godavari	Triploid apogamous	87	87**
O. siliculosum (Desv.) C.Chr.	Nagarjun hill	Diploid	29	58
Adiantum incisum sensu lato	Bishnumati river side	Diploid	30	60
A. philippense L.	Tri Chandra College campus	Triploid apogamous	90	90
PARKERIACEAE				
Ceratopteris thalictroides (L.) Brongn.	Sundarijal	Tetraploid	80	—
DAVALLIACEAE				
Nephrolepis cordifolia (L.) Presl	Swayambhu hill	Diploid	41	82**
ASPIDIACEAE				
Hypodematium crenatum (Forsk.) Kuhn.	Chover hillock	Diploid	41	82
Polystichum auriculatum (L.) Presl	Godavari	Diploid	41	82
Elaphoglossum stelligerum (Wall.) Moore	Nagarjun hill	Tetraploid	82*	—
Dryopteris cochleata (Don) C.Chr.	Budh Nilkanth.	Diploid	41	82
D. paleacea (Sw.) Hand. Mazz.	Thankot	Triploid apogamous	123	123
D. sparsa (Don) Kunze	Chapagaon forest	Diploid	41**	82*
Tectaria macrodonta (Fée) C.Chr.	Budh Nilkanth	Diploid	40	80
Thelypteris erubescens (Wall.) Ching	Shivapuri	Diploid	36**	72
Cyclosorus parasiticus (L.) Farwell	Nagarjune Pharping	Diploid	36	72
C. sumatranus (v.A.v.R.) Ching	Kathmandu	Tetraploid	72	144
Athyrium boryanum (Willd.) Tagawa	Thankot	Diploid	40**	80
A. filix-femina (L.) Roth	Godavari canal side	Diploid	40**	80
A. macrocarpum (Bl.) Bedd.	Swayambhu hill	Diploid	40	80
A. tenellum Wall.	Chapagaon	Diploid	40*	80*
Diplazium esculentum (Retz.) Sw.	Chover	Diploid	41	82
ASPLENIACEAE				
Asplenium dalhousiae Hook.	Swayambhu hill	Diploid	36	72
A. planicaule Wall.	Pharping	Tetraploid	72	144**
A. varians Hook & Grev.	Thankot	Tetraploid	72	144

POLYPODIACEAE				
Goniophlebium lachnopus (Wall.) J.Sm.	Sundarijal	Diploid	36	72
Microsorium lucidum Roxb.	Godavary	Diploid	36*	72*
M. membranaceum (Don) Ching	Nagarjune Thankot Godavary Pharping	Diploid	36**	72
Drynaria propinqua (Wall.) J.Sm.	Sundarijal	Diploid	36	72
Loxogramme involuta (Don) Presl	Shivpuri	Diploid	36**	72**

Comments on individual taxa:

1. *Dennstaedtia appendiculata* (Wall.) J.Sm.

The counts have been made on a specimen collected from stone walls leading to the Chandagiri peak which gave $n=60$ and $2n=120$. Earlier counts of this species from Darjeeling, E. Himalayas (MEHRA & KHANNA 1959) showed $n=66$ (tetraploid) which is not in conformity with our findings. Other species of the genus *Dennstaedtia*, notably *D. hirsuta*, (Sw.) Mett show a base number of 30 (VERMA & KURITA 1961) while *D. scabra* (Wall.) Moore shows $n=33$-34 (BIR 1962). The base number of the present finding conforms with those given by Verma and Kurita from Japan.

2. *Microlepia firma* Mett.

The species counted ($2n=172$) grows in shady places along the road side at low altitudes of 1200—1350 m on the western slope of the Swayambhu Hills.

Another species, *M. speluncae* (L.) Moore from Darjeeling shows a gametic number of 43 (MEHRA & KHANNA 1959), which is most likely the base number of the genus. The present count, therefore, indicates the tetraploid nature of this taxon from Nepal.

3. *Pteris quadriaurita* Retz.

A number of plants of this species from various regions have been cytologically investigated and different cytotypes have been reported (MANTON 1953; MANTON & SLEDGE 1954; WALKER 1962, 1966). The present count shows the prevalence of tripoloid apogamous forms in Nepal. Unfortunately no sixteen celled sporangium could be found and therefore, the triploid nature could not be ascertained.

4. *Pteris tripartita* Sw.

The plants of this species were collected at an altitude of 2400 m on exposed rocks during June-July 1963. They are readily distinguished by their long erect stipes bearing tripartite fronds. Our counts gave $n=29$ and $2n=58$. Earlier reports have shown the existence of a tetraploid sexual form (WALKER 1962; WAGNER 1963) and a tetraploid apogamous form of this species (SCHIFFERDECKER 1957). The present count is the first demonstration of a diploid sexual form of this species occurring in the Himalayas. The existence of various cytotypes of this taxon is interesting as there is the possibility of it being a species complex similar to *Adiantum caudatum* whose diploid cytotypes have similarly been reported from India (ROY & SINHA 1957).

5. *Coniogramme caudata* (Wall.) Ching

The plants assigned to this taxon grow abundantly on moist and shady soil along the north-western slope of Swayambhu Hill at an altitude of 1500 m. Our counts give $n=60$ and $2n=120$; earlier count from Darjeeling (E. Himalayas) was given as $n=30$ (Verma in MEHRA 1961) which suggests that the present report from Nepal is of a tetraploid sexual cytotype of this species.

6. *Cheilanthes farinosa* (Forsk.) Kaulf. *sens. lat.*

The collections were made at an altitude of 1200-1500 m near Tri Chandra College, Kathmandu, Nepal. Herbarium specimens compare with the description given for *C. farinosa* sensu Blanford by MANTON, ROY and JARRETT (1966). The cytological counts of our Nepalese specimen shows it to be a diploid in contrast to *C. farinosa* sensu stricto which is triploid and apogamous and known to occur in India, but so far has not been met with in Nepal. Further intensive survey of this species complex is desirable.

7. *Onychium japonicum* (Thunb.) Kze. var. *lucidum* (Don) Christ

This species grows in the crevices of boulders along the road side on the way to the Royal Botanical Garden, Godavari. The somatic count of 87 chromosomes was made while the 8-celled sporangia showed the formation of 87 bivalents. This is the first account of a triploid apogamous form of the species, although a tetraploid sexual form of this species has been previously reported (Verma in MEHRA 1961) from Darjeeling (E. Himalayas).

8. *Adiantum incisum* Forsk. *sensu lato*

Collections of this species were made at an altitude of 12-1500 m where the plants occur in abundance in open places along road side crevices or rock crevices. For the present report the fixings were taken from the plants growing near the Bishnumati river side. The herbarium specimen compares favourably in morphology and chromosome number with the diploid sexual form reported by ROY & SINHA in 1957 from Patna and subsequently used in hybridization at Leeds (MANTON, GHATAK & SINHA 1967). This report therefore extends the distribution of diploids to Nepal.

9. *Elaphoglossum stelligerum* (Wall.) Moore

The plants grow on shady calcareous soil near the Nagarjun hill. Only meiotic studies could be made which show 82 bivalents in the spore mother cells as in other counts of the genus which have given a base number of 41. The count thus shows this species to be occurring as a tetraploid in Nepal, where its diploid cytotype is not yet known.

A sexual diploid *E. krajinae* Biswas is known from Ceylon along with *E. hirtum* (Sw.) C. Chr. a sexual tetraploid (MANTON & SLEDGE 1954). Further two tetraploids are known from Darjeeling and Mussorie which are *E. conforme* (Sw.) Schott and *E. laurifolium* (Thouars) Moore respectively (BIR 1962).

10. *Dryopteris sparsa* (Don) Kunze

For our cytological investigations the collections were made at Chapagaon forests in moist soil at an altitude of 12-1350 m. The deltoid lamina and smaller indusia distinguish this species readily from others.

The diploid, triploid and tetraploid cytotypes of this species have been known to exist in Darjeeling, N. India (Loyal in MEHRA 1961) but in Kathmandu valley no cytotype other than the diploid ($n=41$; $2n=82$) has been discovered. In contrast, in S. India only a tetraploid is known to occur (ABRAHAM & MATHEW 1962). Our investigations therefore, indicate that the species in Kathmandu valley has remained at the diploid level, while triploids and tetraploids have been evolved in tropical conditions of Darjeeling and S. India, although a diploid is recorded from Teiping Hills, Malaya (MANTON 1954).

11. *Athyrium tenellum* Wall.

This is a common plant in the valley where it forms a thick forest carpet in the jungles. The material for cytological examinations has been collected from the Chapagaon forests. Our counts are $n=40$ and $2n=80$. In another closely related species *A. setiferum* C. Chr. the same gametic count has been obtained.

12. *Microsorium lucidum* Roxb.

The collections were made at an altitude of 1800 m at Godavary beyond the fishery tanks on the way to Phulchoke Peak. It is an epiphyte growing on tree trunks.

The counts made are $n=36$ and $2n=72$. Earlier reports of a diploid taxon with $n=36$ from Garo Hills in N Eastern India has been made (PATNAIK & PANIGRAHI 1963) so the present count further extends the distribution of the diploid cytotype to Kathmandu Valley. In contrast, a tetraploid with $n=72$ has been reported from S India (ABRAHAM & MATHEW 1962).

DISCUSSION

The Kathmandu Valley, which is almost a closed region between the east and west Himalayas, has a rich fern flora from which 53 species have been collected. Of these, 40 species belonging to 26 genera have been cytologically investigated. It has been found that 26 species are at the diploid level and the remaining 14 are polyploids including the apomicts. Apogamy is seen in four species at the triploid level. Comparative data of the diploids and polyploids found occurring in other parts of the Himalayas (MEHRA 1961) and other comparable regions (ABRAHAM & MATHEW 1962; MANTON 1953; MANTON & SLEDGE 1954) has been given in Table 1.

The Kathmandu valley has a warm temperate climate and lies between the east and west Himalayas. Frequency of polyploids in the valley is found to be

TABLE 1

CYTOLOGICAL COMPOSITION OF THE FERN FLORAS OF DIFFERENT REGIONS COMPARABLE WITH KATHMANDU VALLEY

Region	Number of taxa investigated	Percentage of diploids	Percentage of polyploids	Reported by
East Himalayas	251	64	36	MEHRA 1961
West Himalayas	61	77	23	MEHRA 1961
Kathmandu Valley (Central Himalayas)	**40**	**65**	**35**	
South India	108	47	53	ABRAHAM & MATHEW 1962
Ceylon	132	40	60	MANTON 1953; MANTON & SLEDGE 1954

lower than in the east Himalayas, but more than in the west Himalayas. This shows a gradual reduction in the percentage of polyploid taxa from the tropical east to the temperate west. When compared with S India and Ceylon where respectively 53 per cent and 60 per cent polyploids are met with (MANTON & VIDA 1968), the Himalayas show a maximum of 36 per cent polyploids in the east and 23 per cent in the west. The occurrence of 35 per cent polyploids in the Kathmandu valley, which is closed from all regions, is significant. Further, Table 2 shows distribution of various cytotypes of certain species in comparable regions which indicates the retention of the diploids in Kathmandu Valley while other grades of ploidy exist elsewhere.

TABLE 2

LIST OF SPECIES WHOSE VARIOUS CYTOTYPES HAVE BEEN REPORTED

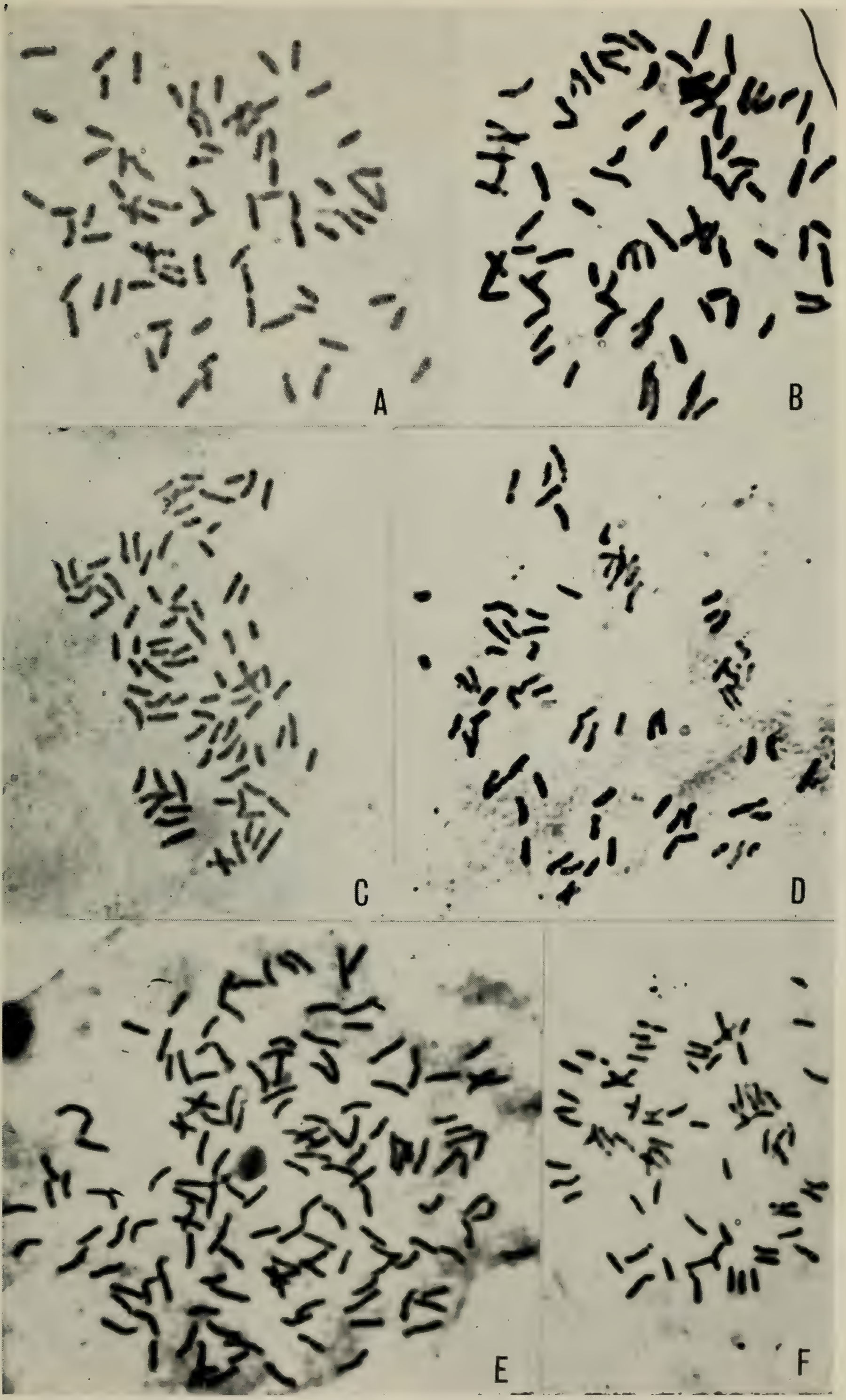
Species	**Diploids**	**Polyploids**
Dicranopteris linearis	Kathmandu Darjeeling Malaya	South India Ceylon
Dryopteris sparsa	Kathmandu Darjeeling Malaya	Darjeeling South India
Cyclosorus parasiticus	Kathmandu	Ceylon South India
Athyrium macrocarpum	Kathmandu Darjeeling Simla	Ceylon
Microsorium lucidum	Kathmandu Garro hills	South India
Loxogramme involuta	Kathmandu	Ceylon

Looking at Table 1 and Table 2, it will be seen that Kathmandu valley is rich in diploid cytotypes which is a common feature with the Himalayas.

ACKNOWLEDGEMENTS

We have to thank the Government of Nepal for granting permission to carry out the investigations. We also thank the British Museum (Nat. Hist.) for providing a xerox copy of the Schifferdecker paper. Further our special thanks are due to Dr Anne Sleep of Leeds who read the manuscript while in Patna in September 1969 and gave us her comments and suggestions. One of us (BMBS) also thanks the authorities of Patna University for granting travel expenses.

PLATE XX. Acetocarmine preparations of mitosis at metaphase; magnification × 1000; **A**: *Dicranopteris linearis* showing 78 chromosomes; **B**: *Pteris quadriaurita* showing 87 chromosomes; **C**: *Onychium japonicum* var. *lucidum* showing 87 chromosomes; **D**: *Nephrolepis cordifolia* showing 82 chromosomes; **E**: *Asplenium planicaule* showing 144 chromosomes; **F**: *Loxogramme involuta* showing 72 chromosomes.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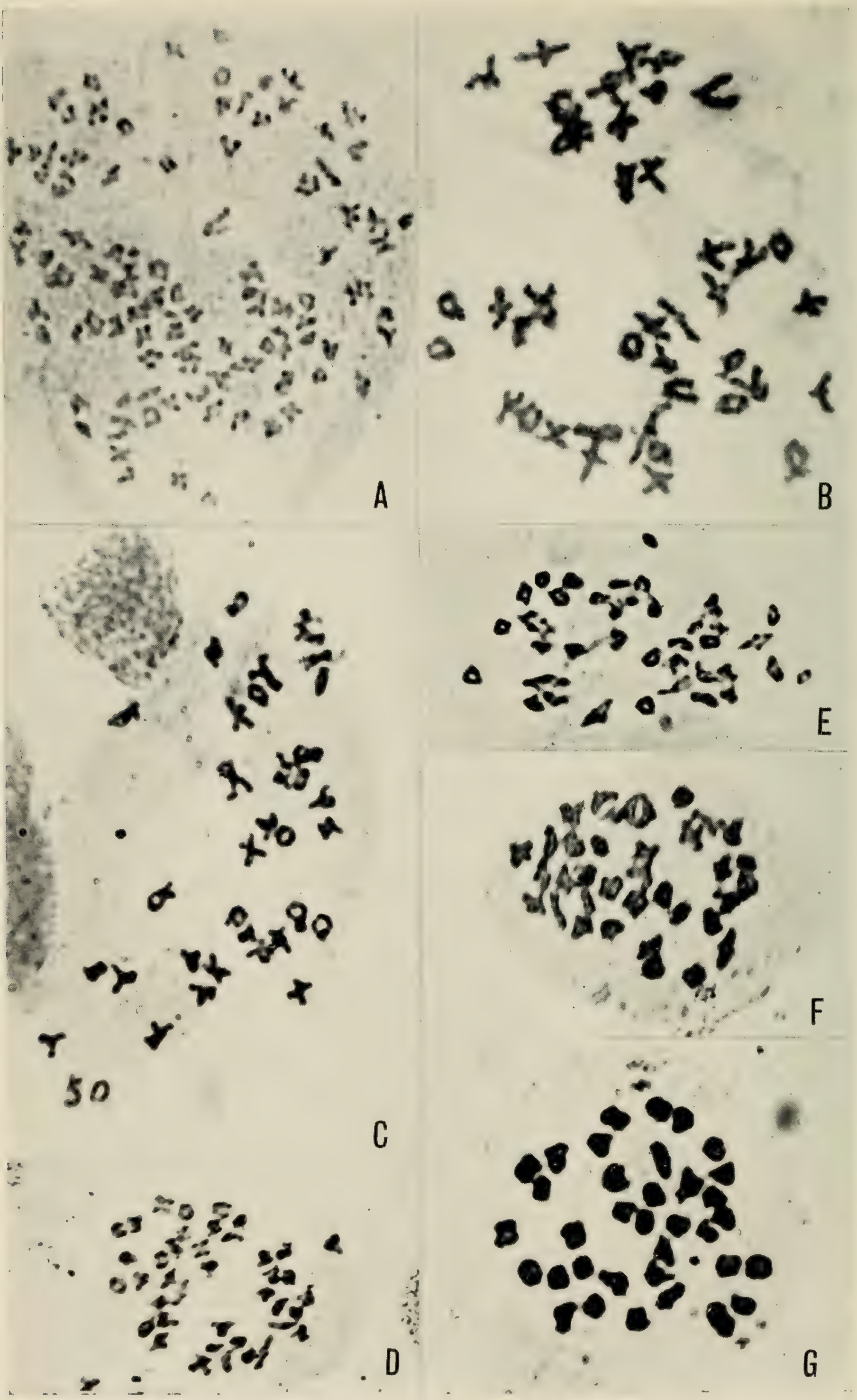
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SCHIFFERDECKER, I. 1957. Untersuchungen über die Gattung Pteris, im besonderen die Zytologie ihrer apogamen Formen. *Zeits. Induk. Abs. und Vererb.* **88**: 163–83.

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WAGNER, W. H. JR. 1963. A biosystematic survey of United States ferns. Preliminary abstract. *Amer. Fern J.* **53**: 1–16.

WALKER, T. G. 1962. Cytology and evolution in the fern genus Pteris L. *Evolution* **16**: 27–43.

WALKER, T. G. 1966. A cytotaxonomic survey of the ptendophyta of Jamiaca. *Trans. Roy. Soc. Edin.* **66**: 169–237.

PLATE XXI. Acetocarmine preparations of meiosis at diakinesis; magnification × 1000; **A**: *Hypolepsis punctata* showing 104 pairs; **B**: *Dryopteris sparsa* showing 41 pairs; **C**: *Thelypteris erubescens* showing 36 pairs; **D**: *Athyrium boryanum* showing 40 pairs; **E**: *Athyrium filix-femina* showing 40 pairs; **F**: *Microsorium membranaceum* showing 36 pairs; **G**: *Loxogramme involuta* showing 36 pairs.

SHORTER NOTES

OBSERVATIONS ON SPANISH FERNS

***Diplazium caudatum* (Cav.) Jermy.** This fern is native to the Açores, Canaries and Madeira, but had not been recorded for the mainland of Europe until I found a few plants in the Cadiz Province in 1969. This is yet another example of the macaronesic flora occurring amongst the atlantic and mediterranean plants in this interesting south-west corner of Andalucia.

I suspect, however, that Pierre Allorge may have seen it growing near *Culcita macrocarpa*, but for some reason did not recognise it. In his account of the ecology[1], which has changed surprisingly little where the *Culcita* grows, he records *Polystichum spinulosum* Lam. & DC. (=*Dryopteris carthusiana* (Vill.)H.P.Fuchs). Neither *Dryopteris* nor *Polystichum* occur in these valleys so far as I know, and it seems unlikely that this *Dryopteris*—a mountain species in the south—was growing down here at such a low altitude. I wondered, therefore whether it could have been a small *Diplazium caudatum* which may superficially look similar to this other species. It would mean of course that no specimen was collected or retained, for the difference should have been apparent to this botanist. I have not yet been able to find out if there is any specimen in Paris.

Well grown, *Diplazium caudatum* is a fine fern with long and shiny black stipes and dark green laminae. The largest frond that I measured was almost two metres in length (including the stipe) which is considerably larger than is given in *Flora Europaea*[2]. The black rhizome is remarkable for its size; one was 32 by 20 cm. and about 6 cm. deep, and was growing on the surface of wet earth, but anchored by extraordinary long thick rootlets.

Unfortunately this fern grows by rocky rivers, stream edges and occasionally actually in the river-beds, thus suffering during the winter rains. This year flooding was excessive for eighteen days, and when I later saw the plants, only battered and broken fronds remained. Some seemed to have disappeared, but it was difficult to be sure as the river had changed. The reason it survives here where so much clearing and burning has taken place, in turn causing erosion and undue flooding during the winter, is most likely due to its enormous rhizome which is firmly held by the anchoring rootlets.

***Pteris serrulata* Forsk.** There have been different schools of thought on the status of *Pteris serrulata* being native to the mainland of Europe. Originally, its presence was based on a collection made in the Cintra hills in Portugal in 1848, but nothing more seems to have been heard of it. It is reported in *Flora Europaea*[3] as a garden escape. Thus in Europe *P. serrulata* was represented only in Açores and it was also recorded from Tangier in north Africa, the Canaries and Madeira.

In 1968 I found a solitary plant in a rather remote range of hills in Cadiz province, at 240 metres in altitude. Growing under tall Alders on sloping ground in the woods of *Quercus suber* and *Q. faginea*, near a rocky summit, it was between two rocks where water permanently seeped. The rhizome was well hidden underneath, in a shelter formed by the rocks. It seemed to be in a natural habitat, and Professor Galiano from Seville University, who was with me, felt sure that it must be native, but we were both anxious to find more of it elsewhere.

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[1] ALLORGE, P. 1934. *Bull. Soc. Bot. France* **81**: 592.
[2] JERMY, A. C. 1964. In *Flora Europaea* **1**: 18.
[3] WALKER, T. G. 1964. In *Flora Europaea* **1**: 11.

Early in 1970 I found two more adult plants and two young ones at 450 m. This is in another remote area to the west of Los Barrios and in another range of hills from the original one, and several kilometres distant as the crow flies. They were in a most distinctive plant community; the ground was strewn with sharp rocks and because of dense low growth, hanging lianes and being most difficult to penetrate, was very reminiscent of tropical secondary growth. I have now no doubt at all that this fern is native here in Spain and thus native to the European mainland after all. It is possible that the Portuguese plants which were found over 100 years ago were the remnants of a native colony which was then fast disappearing, and not escapes from plants brought from Madeira to Cintra gardens.

***Trichomanes speciosum* Willd.** *Trichomanes speciosum* is a rare and local fern, for apart from its localities in Britain and Ireland, it is known from the European mainland by only a few citings from Galicia in Spain, from France and Portugal. Although this fern has been found in the past in the north-west of Spain, it is still rare enough to warrant recording its occurrence in this extreme south-west corner of Andalusia.

It grows in the valleys which lie between the hills of Los Barrios-Algeciras districts and I have found it in two widely separated places. In the main area, *Trichomanes* grows in patches near *Culcita* and *Diplazium caudatum* but although fairly common, very few of the colonies have fronds large enough to be fertile. This year, after a severe flooding, many small patches had disappeared, mainly from vertical sides of boulders in the river-beds. Some of the larger colonies were much depleted, but later in the spring, I found many new fronds appearing. The species grows where there is constant moisture, hanging from rocks over water or in small fissures where there is a permanent seepage. In one case, however, a small patch was found in the ground above a stream, but was protected by two rocks forming a narrow shelter. This place did not seem to be continually moist, but would be well sheltered during the summer by tall *Osmunda regalis.*

***Culcita macrocarpa* C. Presl.** This fern was collected near Algeciras in the Cadiz Province of south-west Spain in 1869 by a Col. White[4]; it was seen again (probably here) in 1929 by L. Ceballos and in 1933 by P. Allorge[5]. More recently it has been recorded from Galicia in north-west Spain by Father Lainz[6] and it is also known from at least one locality in Portugal. Until recently it was not known whether it still existed near Algeciras where so much has been cleared since the civil war. Urged on by Professor Galiano and Dr Holttum, I looked for it but was misled by Col. White's remark "on rocks by Gibraltar" and, even with permission to examine the coastal military areas, I found nothing. When Dr Jarrett however, sent me a xerox copy of Allorge's paper, the rest was easy. There it was, well inland, probably not so abundant as in 1933 but certainly not rare.

It grows from about 200-230 metres in altitude on steep valley sides and by mossy rocks near swift flowing small rivers, and I have found it as high as 450m in the same valley. There is also a very large colony in another valley several kilometres away in another range of hills near the Sierra del Niño. Fortunately this is in private property and so should survive, but in both places the fern is in great danger of fire, which is becoming increasingly common during the long dry summers. Also, with continual clearing, brambles and bracken are rapidly encroaching amongst the plants themselves. Although a stout fern, it seems slow to mature and fronds tend to become fertile only when the plant is large. There is added danger from at least one area, namely, from fern collectors, for it has suddenly become extremely popular with students from certain European countries (*not* Spain) who collect to sell.

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[4] WHITE. herb. spec. at R.B.G., Kew.

[5] ALLORGE, P. 1934. *Bull. Soc. Bot. France* **81**: 592.

[6] LAINZ, M. *Aport. Fl. Gallega* **6**: 36.

Culcita is a beautiful fern when seen in its natural habitat; the lamina is yellowish-green and shiny, and the whole frond may be over two metres tall. The light reddish-brown sori are usually confined to the upper half or third of a lamina and are so heavy and produced in such abundance that they weigh the frond-tips down.

Cyclosorus dentatus **(Forsk.) Ching.** In *Flora Europaea*[7] the distribution of this fern does not include continental Europe, being recorded only on the islands of the Açores.

I found it in Spain however, in 1968 in the Los Barrios district of the Cadiz province[8]. It was with great surprise that I saw it and recognised it as a *Cyclosorus*, for it was so like *C. subpubescens* which I had seen often enough in Singapore. The Spanish plants grow in a somewhat similar habitat also, for Holttum[9] says of it . .". . grows in slightly sheltered places, not in primitive forest and not in full sun . .".

For a while I doubted its native status as I had found only one patch, but Alston[10] says of the west African plants, that they are often by streams in secondary growth which describes exactly the habitat of the Spanish specimens. Since then I have found that it is locally common on the edges of a flat sluggish stream under Alders and *Rhamnus alaternus* and effectively screened by brambles and which makes some sort of barrier against damage from goats.

There seems to be no reason to suppose that *C. dentatus* has been introduced; it is not cultivated here to the best of my knowledge, and seems to be in a sufficiently remote area to be growing naturally. Thus it represents a new genus for the European mainland.

Los Barrios, Spain. B. MOLESWORTH-ALLEN

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[7] JERMY, A. C. 1964. In *Flora Europaea* **1**: 14.
[8] MOLESWORTH-ALLEN, B. 1969. *Bol. R. Soc. Española Hist. Nat.* (*Biol.*) **67**: 75.
[9] HOLTTUM, R. E. 1966. *Ferns of Malaya* (ed. 2): 274.
[10] ALSTON A. H. G. 1959. *Ferns and fern allies of W. Tropical Africa*: 61. London.

A NOTE ON *POLYSTICHUM BRAUNII* VAR. *KAMTSCHATICUM*

This fern was collected by E. Hultén from several localities in south Kamtchatka during his expedition of 1920-22, and was described as a variety of *P. braunii* by Christensen in Hultén (1927).[1] What, from the description, appears to be the same plant, was described as *P. braunii* var. *subsessile* by Komarov[2] in his Flora of the Kamtchatka peninsula, published in the same year. Three years later Fomin[3] raised Christensen's taxon to specific rank, quoting *P. braunii* var. *subsessile* Kom. as a synonym.

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[1] HULTEN, E. 1927. Flora of Kamtchatka and the adjacent islands, I. *K. svenska Vetensk-Akad. Handl.* s.3, **5** (1): 38-39 & t. 2.

In Japan it has been generally accepted for some time that *P. braunii* var. *kamtschaticum* was most probably identical with *P. microchlamys* (Christ) Matsum., a quite different species of *Polystichum* found in northern Japan, although, as far as I know, a detailed comparison of the type material of each taxon has never been made. Professor Nakai was certainly of the opinion that the Kamtschatkan plant, judging from the description and photograph given in Hultén's Flora of Kamtchatka, seemed to correspond exactly to the Japanese *P. microchlamys*, and his judgement is accepted and quoted by Miyabe and Kudo[4]. Other Japanese authors (Ito[5], Namegata & Kurata[6], Ohwi[7], Sugimoto[8], Tagawa[9] and Takeda)[10] have followed this decision, and all include Kamtchatka as within the known distributional range of *P. microchlamys*. It is interesting to note that, in the latest (English) edition of Komarov's Flora of the U.S.S.R.,[11] *P. braunii* var. *kamtschaticum* has been reduced to a synonym of *P. microchlamys*.

This species was first described, under the name of *Aspidium microchlamys*, by H. Christ,[12] from a collection of Faurie's from Iidesan, Japan, and was subsequently transferred to the genus *Polystichum* by Matsumura[13] in 1904. Some slight confusion over the correct authority has arisen because Kodama[14] made the same combination again in 1915, the earlier publication of Matsumura apparently being overlooked. Excellent illustrations of *P. microchlamys* are to be found in Matsumura[15] and in Ogata.[16]

Apart from *P. braunii*, the only other taxon which appears to have been confused with *P. microchlamys* is *Polystichum bakerianum* (Atkins.) Diels. Christensen[17] equated Christ's *Aspidium microchlamys* with *Polystichum bakerianum*, and this opinion has given rise to some confusion in the literature. I have examined the illustration of *P. bakerianum* given by Hooker,[18] and it is my opinion that this taxon is a totally different plant not closely related to *P. microchlamys*. Christensen appears to have come to the same conclusion, for in Supplement 3 of the Index

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[2] KOMAROV, V. L. 1927. *Flora peninsulae Kamtschatka*: 64. Leningrad.

[3] FOMIN, A. 1930. *Flora Sibiriae et orientis extremi* **5**: 94. Leningrad.

[4] MIYABE, K. & KUDO, Y. 1930. Flora of Hokkaido and Saghalien, I. *J. Fac. Agric. Hokkaido imp. Univ.* **26**: 23.

[5] ITO, H. 1944. *Fil. Jap. Illustr.* 300. Tokyo.

[6] NAMEGATA, T. & KURATA, S. 1961. *An Enumeration of the Japanese Pteridophytes.* In Namegata T. *Collection and Cultivation of our Ferns and Fern-allies*: 313. Tokyo.

[7] OHWI, J. 1965. *Flora of Japan* (English ed.) Smithsonian Institution, Washington, D.C.

[8] SUGIMOTO, J. 1966. *Keys to Herbaceous Plants of Japan.* 3. *Pteridophyta.* Osaka. (in Japanese).

[9] TAGAWA, M. 1959. *Coloured Illustrations of the Japanese Pteridophyta*: 83, 161. t. 61 Osaka.

[10] TAKEDA, H 1965 *Alpine Flora of Japan in colour*, **2**: 67. Osaka.

[11] KOMAROV, V. L. (Ed.) 1968. *Flora of the U.S.S.R.*, **1**: 36-39. (English ed.) Israel Program for Scientific Translation, Jerusalem.

[12] CHRIST, H. 1899. *Bull. Herb. Boiss.* **7**: 820.

[13] MATSUMURA, J. 1904. *Index Plantarum Japonicarum sive Enumeratio Plantarum Omnium* **1**: 343. Tokyo.

[14] KODAMA, S. 1915. *Bot. Mag. Tokyo* **29**: 326 (in Japanese).

[15] MATSUMURA, J. (Ed.) 1915. *Icones Plantarum Kioshikawenses*, **3**: 3, t. 147. Tokyo.

[16] OGATA, M. 1935. *Icones Filicarum Japonicarum* **6**, t. 289.

[17] CHRISTENSEN, C. 1905. *Index Filicum.* Kobenhavn.
—— 1934. *Ibid. Supplement* 3. Kobenhavn.

[18] HOOKER, J. D. 1886. *Icones Plantarum* **17**, tab. 1656, London.

Filicum he deletes both Japan and *A. microchlamys* from the entry under *P. bakerianum*, and accepts *Polystichum microchlamys* as a distinct species confined to Japan.

It is interesting to note that, in spite of the fact that Christensen was aware of the existence of this Japanese taxon, he does not appear to have realised the close similarity between it and the plant which he had described from Kamtchatka as *P. braunii* var. *kamtschaticum*.

Recently an opportunity arose for me to compare the type material of *P. braunii* var. *kamtschaticum* (in Herb. BM) with the type material of *P. microchlamys* (in Herb. Paris). As had been expected, the two specimens were almost identical, and there is no doubt at all that they are in fact the same species. In addition to this, both specimens correspond very closely to fronds of *P. microchlamys* collected by myself from various localities in Japan during 1967-69.

It was also possible to compare material of both *P. microchlamys* and *P. braunii* var. *kamtschaticum* with specimens of *P. braunii* from different parts of the northern hemisphere, including north America, Europe and Japan. *P. braunii* is a highly distinctive and easily-recognised species which shows remarkably little variation throughout its range, and it can readily be distinguished from *P. microchlamys* in a number of important respects, as may be seen by reference to the following Table:

	P. microchlamys **P. braunii var. kamtschaticum**	**P. braunii**
1.	**Fronds** bipinnatipartite.	Fronds fully bipinnate.
2.	**Pinnae** long-tapering, attenuate.	Pinnae generally obtuse, bluntly rounded, not attenuate (although the upper pinnae may be shortly acuminate).
3.	**Upper surface** of pinnules glabrous or nearly so.	Upper surface of pinnules clothed with soft hairs.
4.	**Pinnules** only slightly auricled, oblong-lanceolate in shape, acute, coarsely and sharply toothed.	Pinnules rhomboid in shape, obtusely auricled at base, softly aristate.
5.	**Pinnules** obliquely inserted, semi-adnate and with a decurrent base. Costa alate throughout.	Pinnules distinctly, although shortly, stalked, inserted at right angle to mid-rib of pinna.
6.	**Proximal acroscopic pinnule** slightly larger than the rest.	Proximal acroscopic pinnule not conspicuously longer than the next.

It is thus apparent that the Kamtschatkan material is quite distinct from *P. braunii*, and should not, therefore, be regarded as a variety of that species.

P. microchlamys and *P. braunii* are two particularly interesting ferns, for although they are clearly two totally distinct species, they show some interesting parallels in their distribution patterns and ecological preferences. *P. microchlamys* seems to have a restricted distribution within a rather limited area of the Far East, while *P. braunii* is a circumboreal species of wide distribution in the northern hemisphere. Both are woodland ferns. *P. braunii* is nearly always to be found in shady places in coniferous forests in montane regions, and in Europe it tends to prefer humus-rich soils and is never very far from running water. In Japan the distributions of these two species overlap, and they may sometimes be found growing together. As far as I am aware, typical *P. braunii* is not known from Kamtchatka although it could conceivably occur there. In this peninsula *P. microchlamys* is said to occur in shady gullies and glades among alder thickets, although in Japan it appears to be restricted to coniferous forests. It is a very rare species, and can never be found in great quantity. It usually occurs in company with *Polystichum retrosopaleaceum*, a widespread and common fern in mountainous regions throughout Japan, and in the northernmost island of Hokkaido it is often accompanied by such familiar circum-boreal species as *P. braunii*, *Dryopteris austriaca*, *Phegopteris connectilis* and *Gymnocarpium dryopteris*. Hybrids are of frequent occurrence within the genus *Polystichum*, and *P. microchlamys* is no exception. Hybrids between it and *P. retrosopaleaceum* are relatively common, and are conspicuous by their enormous size. It is hoped to make a report on the cytology of such hybrids in due course.

P. microchlamys shows a northern distribution in Japan, where it occurs sporadically in coniferous forests in Hokkaido and in Honshu. On the main island it seems to be restricted to mountainous regions in the north and west, and it is noteworthy that it is very much more common on the Japan Sea side of Honshu than it is elsewhere (Kurata[19]), a phenomenon which is possibly influenced by the high winter precipitation in these areas. Outside Japan this fern is known only from Kamtchatka and from the island of Shumushu in the northern Kuriles. Specimens from this island described as *Aspidium aculeatum* Sw. var. *lobatum* Yabe & Yendo[20] were thought to be identical with the Kamtschatkan plants by both Miyabe & Kudo and Hultén, and I have accepted their opinions on this matter. Unfortunately, it appears that the specimens in question have long been lost from the herbarium of Tokyo University. It is also possible that specimens collected by Stejneger[21] (see Fedtschenko[22]) from Copper Island in the Commander group (off the eastern coast of Kamtchatka), and identified by Gray as *Aspidium aculeatum*, may possibly be referred to *P. microchlamys*.

Although not so far recorded, it seems to me very likely that *P. microchlamys* will also be found on the island of Sakhalin. Sugawara[23] lists only three species of *Polystichum* as occurring on the island: *P. lonchitis*, *P. tripteron* and *P. braunii*. However, it is most interesting to note that in this work the frond illustrating *P. braunii* is almost certainly not that species, but is *P. microchlamys*! It is therefore to be hoped that a specimen of *P. microchlamys* from Sakhalin may yet turn up in some neglected herbarium.

Botany Dept., Leeds University. ANNE SLEEP

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[19] KURATA, S. 1964, *Sci. Rep. Yokosuka Cy Mus.* **10**: 17-41.
[20] YABE, Y. & YENDO, K. 1904. *Bot. Mag. Tokyo* **18**: 167. (in Japanese).
[21] STEJNEGER, L. 1885. *Proc. U.S. Nat. Mus.* **7**: 529.
[22] FEDTSCHENKO, B. 1906. *Flore des îles du Commandeur*: 127. Cracov.
[23] SUGAWARA, S. 1937. *Illustrated Flora of Saghalien* **1**: 39-43. t. 19-21.

THREE PTERIDOPHYTES NEW TO THE CANARY ISLANDS

The Canary Islands lie four and a half degrees north of the tropic of Cancer and from sixty to two hundred miles off the coast of West Africa. This archipelago of seven main, high and very rugged, islands of volcanic origin harbours a flora and fauna of considerable biological interest. In relation to their small landmass, the flora is a rich one: more than 1,500 species of vascular plants are listed by Lems,[1] including about 40 pteridophytes. Most years a few species of flowering plants are added to the list as botanical exploration reveals them, and here, a further three species of pteridophytes are added to the Canary Islands flora. These records were made in the field by the author on two Newcastle University expeditions in 1963 and 1964 to the three more remote western islands of the Canaries group, namely La Palma, Hierro, and Gomera.

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[1] LEMS, K. 1960. *Sarracenia* **5**: 1-94.

1. *Selaginella selaginoides* (L.) Link. A few shoots only amongst an abundant growth of moss species in a deep, damp fissure in the lava rock of a steep north-facing cliffside below the peak of Malpaso and above the Valverde-Sabinosa road, El Golfo, Hierro, ca. 1200 m, July 1964. *T. J. Bines and C. N. Page No. C*491. Specimen in hb. BM.

The plant is similar to the European *S. selaginoides* in size and habit, but has rather well-differentiated cones containing, in the shoots collected, only megasporangia. No opportunity of establishing its chromosome number has yet occurred and live material of the plant is now greatly to be desired.

Hierro, the most southerly and westerly island of the Canaries group (lat. 27½°N), represents an extremely outlying station for this species. *S. selaginoides* is unknown from any of the other Canary Islands and is unrecorded for the Cape Verde Islands, Madeira, or the Açores—archipelagos with which the flora of the Canary Islands has much in common. It is a species of circumboreal distribution generally confined to mountains and high latitudes of Europe, Asia, and America, and its nearest station to the Canary Islands is north Spain, 1,300 miles (2100 km) distant. The only other taxonomically related plant is *Selaginella deflexa* Brackenridge, which is an endemic of the Hawaiian archipelago and on a more nearly similar latitude to that of the Canary Islands.

So far-distant from its nearest previously known station, the local status of this plant may well be called into question but the improbability of its having been brought to the islands with any domestic or horticultural purpose in mind, or introduced accidentally into this remote locality, strongly suggests that *S. selaginoides* is native to the Canaries flora. There are also small morphological differences between it and its European counterpart suggesting that this colony has been separate for some time.

2. *Dryopteris pseudomas* (Woll.) Holub and Pouzar. Terrestrial in open *Erica-Ilex* forest on well-drained banks in cloud forest at the head of Barranco Vallehermoso, west Gomera, ca. 840-870 m, August 1964. *C. N. Page Nos. C*317, *C*412, *C*416 *and C*430. Spores of C416 raised in cultivation at Newcastle, prothalli apogamous, 2n=ca. 82 from root tips. Specimens of C416 in hb. BM.

Terrestrial in thin laurel forest on well-drained slopes, El Cedro, central Gomera ca. 840 m, August 1964. *C. N. Page Nos. C*528 *and C*535. Spores from both raised in cultivation at Newcastle; both have apogamous prothalli and gave 2n=ca. 82 from root tips. Specimens of C528 and C535 in hb. BM.

Several dozen plants were seen at each of the two Gomera stations, and at the former, plants occurred in two separate but nearby patches. All large plants were sparsely fertile and formed part of a mixed fern association that included *Polystichum setiferum* (Forsk.) Woynar, *Diplazium caudatum* (Cav.) Jermy (*Athyrium umbrosum* (Ait.) Presl), and *Dryopteris oligodonta* (Desv.) Pichi-Sermolli.

D. pseudomas can be distinguished from other Canary Island species of *Dryopteris* by having fronds of relatively small size (up to about 60 cm in length) which are stiff and borne more or less erect in a crown from an erect rhizome. These fronds are once pinnate with the pinnae pinnatifid and have an elliptical outline narrowing gradually towards the base. The stipe is very short (1/12–1/10 length of frond) abundantly covered with long golden-brown scales which are uniform in colour and ascend the rhachis for much of its length.

These Canary Island specimens compare particularly favourably with plants from Madeira, the nearest previously known locality for *D. pseudomas*, from where the var. *atlantica* has been distinguished by von Tavel.[2] They have the small sori and short stipe which distinguish var. *atlantica* from the more typical European form, though the pinnae in my Canary specimens are not so attenuated as those on some specimens from Madeira.

In addition to Madeira, Dansereau[3] indicates the presence of *D. pseudomas* in the Cape Verdes (as *D. borreri* Newm. var. *affine* (Lowe) Menzes) although I have not seen specimens from this locality, and Ward[4] records the plant from the Açores. Von Tavel gives also "Spain" for var. *atlantica* which brings the variety into the category of a Macaronesian-Lusitanian element in the Canary fern flora alongside such species as *Asplenium hemionitis* L., *Davallia canariensis* (L.) Sm., *Culcita macrocarpa* Presl, and others. This discovery of *D. pseudomas* on Gomera in two separate localities in a type of forest which is a common habitat on this island and on neighbouring La Palma and Teneriffe, suggests that further searching in these areas may yet show it to be more widely distributed in the Canaries. The isolated location of these plants in two independent and apparently undisturbed forest areas with other native fern species and remote from habitation gives every indication that *D. pseudomas* is native to the Canaries flora.

3. *Asplenium anceps* von Buch. A few plants on outcropping mossy boulders in laurel forest with a northerly exposure, Barranco del Rio west of Barlovento, northern La Palma, ca. 900 m, August 1963. *C. N. Page No. C*86.

A single plant only in a shaded fissure in a lava cliff face with northerly exposure, El Golfo, Hierro, ca. 1275 m, July 1964. *C. N. Page No. C*315.

A single large plant on an earth bank in laurel forest with *Asplenium hemionitis*, Barranco del Cedro, El Cedro, central Gomera, ca. 1200 m, August 1964. *C. N. Page No. C*509.

Asplenium anceps was reported from the Canary Islands in the early days of botanical exploration by Bolle,[5] who gave a description of material gathered on La Palma, which differed from *A. trichomanes* principally in having a third 'wing' or 'keel' along the length of the rhachis. Possibly because further collections of this plant from the Canaries have remained largely, if not entirely unknown, and because large plants of *A. trichomanes* L. subsp. *quadrivalens* D. E. Meyer emend. Lovis can be found in humid pockets in all five western islands of the Canaries, recognition of *A. anceps* as a Macaronesian species has not been given by modern authors on the floras of these islands. Instead, both in the Canaries and in the other Macaronesian archipelagos the species of the *A. trichomanes* group have been generally lumped into a single taxon to which the names *A. trichomanes* L. var. *majus* Mett., or *A. trichomanes* L. var. *anceps* (von Buch) Menezes have been liberally applied. Plants agreeing with the description of *A. anceps* have been known recently only from Madeira collected by Manton (J. D. Lovis, personal communication). The above three collections now re-affirm the presence of *A. anceps* as a good species in the flora of the Canary Islands. A fourth Canary Island gathering of this species has also recently been found amongst material in herb. B.M. collected by R. V. Sherring and merely labelled "Teneriffe, 1930". As several other gatherings of Canary Island ferns made by Sherring are recorded to be from the Las Mercedes forest area of Teneriffe, the specimens of *A. anceps* may also be from this locality.

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[2] VON TAVEL, F. 1937. *Verh. der Schweiz. Naturforsch. Ges.* **118**: 153-154.
[3] DANSEREAU, P. 1961. *Agronomia Lusitana* **23**: 151-181.
[4] WARD, C. M. 1970. *Brit. Fern Gaz.* **10**: 119-126.
[5] BOLLE, C. 1866. *Zeit. Ges. Edk. Berlin.* **1**: 209-238, 273-287.

Though apparently very rare, *A. anceps* s.s. has thus occurred on at least the four westernmost islands of the Canaries, and still survives in the three stations discovered by the author. Elsewhere in the Atlantic Islands, its presence on Madeira has been confirmed, and it may yet be detected on the Açores and perhaps even in the Cape Verdes. Outside Macaronesia it is unknown, with the exception of a plant described by Nakai[6-7] as *Asplenium anceps* var. *proliferum*. If the two are conspecific, then *A. anceps* possesses the extremely disjunct geographical distribution of the Canaries, Madeira and the island of Shikoku in southern Japan.

I would like to acknowledge with gratitude the financial help received towards the cost of mounting the two expeditions to the Canary Islands from Newcastle University Exploration Council, to the Science Research Council for a Research Studentship under which the collections were studied, to Dr J. D. Lovis for determination of the material of *A. anceps*, and to Dr T. G. Walker, Professor J. H. Burnett, and Mr A. C. Jermy for their help and encouragement throughout.

Botany Department, University of Newcastle upon Tyne. C. N. PAGE

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[6] NAKAI, T. 1930. *Bot. Mag. Tokyo* **44**: 7-40.
[7] NAKAI, T. 1933. *Bot. Mag. Tokyo* **47**: 172.

POLYSTICHUM HYBRIDS IN BRITAIN

During the preparation of an account of the genus *Polystichum* for the forthcoming B.S.B.I. publication on Hybridisation in the British Flora (Ed. Stace), I became interested in the distribution of the hybrid *Polystichum* × *bicknellii* (Christ) Hahne (=*P. setiferum* × *P. aculeatum*). A study of specimens of both parents in various herbaria yielded at least twenty hitherto undetected hybrids, and the available evidence suggests that *P.* × *bicknellii* may be more widely distributed in Britain than had previously been thought to be the case. It would be a great help if anyone interested could look out for this fern in the field, so that its exact distribution can be mapped. Herbarium specimens (which must bear ripe sporangia) should be sent to: Dr Anne Sleep, c/o Department of Botany, British Museum (Natural History), Cromwell Road, South Kensington, London, S.W.7.

The hybrid *P.* × *bicknellii* is very difficult to recognise, for the two parent species are themselves extremely variable. It has therefore been thought helpful to list here some of the more useful characters for distinguishing between *P. aculeatum* and *P. setiferum*.

	P. setiferum	**P. aculeatum**
1.	Fronds fully bipinnate.	Fronds variable, pinnatifid to 2-pinnate.
2.	Fronds generally soft in texture, spreading, not markedly narrowed towards the base.	Fronds stiff and shiny, narrow, usually markedly contracted towards the base.

3.	Basal pinnae pinnate, long and spreading, usually only a little smaller than the pinnae in the middle part of the frond, and sometimes forwardly projecting.	Basal pinnae pinnatifid, 2 to 3 times smaller than the pinnae in the middle part of the frond.
4.	Pinnules stalked, squarish in shape and with a distinct auricle; angle at pinnule base 90 deg. or more.	Even when fully bipinnate, the pinnules tend to be adnate and not distinctly stalked. Pinnules acute, narrow and obliquely inserted; angle at pinnule base acute and not obtuse.
5.	Spores small (average 30.5μm), pale yellow in colour, with winged perispore. Not papillate.	Spores dark brown in colour, papillate, markedly larger than those of *P. setiferum* (average 41·3μm).

As expected, the hybrid *P.* × *bicknellii* is intermediate in most of the characters described above, although a complete range of morphological variation is possible, and hybrid plants may sometimes be mistaken for either one or the other of the parent species. The fronds are usually bipinntae, resembling the *setiferum* parent, although the pinnules may be either adnate or stalked (when stalked, the angle at the base of the pinnule is acute and not obtuse). Typically, the frond is narrower than in *P. setiferum*, and is usually contracted towards the base as in *P. aculeatum*. The spores are abortive, and, providing a microscope is available, quick scrutiny of the contents of the sporangia is the best single method of identifying this hybrid.

P. × *bicknellii* is likely to occur wherever the parents grow together. In spite of the fact that *P. setiferum* is more common on humus-rich soils in woods and shady hedgebanks in the south and west, while *P. aculeatum* seems to prefer light soils and rocky habitats further north, their ecological ranges do overlap and they may be found growing together in many parts of the British Isles. Likely places to search for these two species are disused quarries, steep ravines and wooded river valleys.

There is one other *Polystichum* hybrid which could conceivably be found in Britain, and that is *P.* × *illyricum* (Borbas) Hahne (*P. lonchitis* × *P. aculeatum*). This is a widespread and common fern on the continent, and it could perhaps be found in Scotland, in places where *P. lonchitis* is more abundant and may occur together with *P. aculeatum*.

University of Leeds
ANNE SLEEP

A NEW HYBRID FERN FROM THE CHANNEL ISLANDS

During the recnt excursion of the British Pteridological Society to Guernsey, we were fortunate enough to discover several plants of a hitherto undescribed hybrid within the genus *Asplenium*. The first hybrid was discovered by myself, growing in a sheltered, ivy-covered hedgebank close to the reservoir, and subsequently several other plants were found in similar habitats in other parts of the island. In all cases the hybrids were found in places where both *Asplenium billotii* and *A. adiantum-nigrum* were growing in abundance (no other Aspleniums being present), and, since these hybrids are clearly intermediate between these two species, there seems little doubt that they represent a cross between *Asplenium billotii* and *A. adiantum-nigrum*. Spores from five different stocks were examined, and all were uniformly abortive. Material of this hybrid is now in cultivation at Leeds, and it is hoped to present a report on the cytology of this most interesting plant in a subsequent communication.

Asplenium × **sarniense** Sleep, **hybr. nov.** (*Asplenium billotii* F. W. Schultz × *A. adiantum-nigrum* L.)
Planta hybrida, media inter parentes. Similis *A. adianti-nigri* et (i) frondibus triangularibus, bi- vel tri-pinnatis, conspicuas pinnas basales habentibus et (ii) pinnis petiolatis, deltatis, par proximale pinnularum magnum, valde evolutum, saepe pinnatum habentibus. Ab hac specie distinguitur characteribus pinnularum quae sunt et distincte, quamvis breviter petiolatae etiam ad extremitatem pinnae distalem et ovales, habentes apices obtuse rotundos cum dentibus brevibus mucronatis. Sporae abortivae.

Holotype: Guernsey, Channel Islands: lane near St. Peter's Church, Les Pres, St. Peter-in-the-Wood. Growing in rich, sandy loam in tall hedgebank by roadside, together with both parents, and *Hedera helix* L. (dom.), *Umbilicus rupestris* (Salisb.) Dandy (a), *Brachypodium sylvaticum* (Huds.) Beauv. (c), *Heracleum sphondylium* L., *Teucrium scorodonia* L. and *Rubus* sp. (o). Alt. c. 45 m.
Legit: B. Makin & Anne Sleep, 23.4.71. Plant cultivated in Leeds under number AS/1102. Two fronds (AS/1102) deposited in the herbarium of the British Museum (Natural History). Isotypes bearing the same number and date will be deposited in the following herbaria: Royal Botanic Gardens, Kew (K), the Botanic Garden and Museum, Berlin-Dahlem (B), the University of Leeds (LDS), and the herbarium of the Société Guernesiaise at St Peter Port (STP).

Hybrid plant, generally intermediate between the parents, although easily overlooked as a state of *A. adiantum-nigrum*. *Fronds* 12–38 cm long (average c. 30 cm), 5–15 cm broad (average 8 cm). *Rhizome* short erect, clothed with numerous filiform, pale brown scales. *Petiole* generally 1/3 to 1/2 the length of the blade, the underside dark brown in colour, the upper either brown or green. *Rhachis* rather variable in colour, the upper side usually green and the underside frequently dark brown below, the dark colouration extending from the petiole base to the 2nd or even 6th pair of pinnae. *Fronds* usually dark green in colour, bipinnate to tripinnatifid, narrowly triangular in shape (sometimes deltoid), with the basal pair of pinnae the largest. *Pinnae* triangular in outline, very shortly stalked, pinnate to bipinnatifid, spreading and sometimes even reflexed; tip shortly acuminate and bearing rounded, mucronate teeth. Proximal pairs of pinnules large, very prominent, and again subdivided, with the proximal basiscopic pinnule almost equalling the proximal acroscopic pinnule in size and development. Basal pinnae conspicuous, even in poor specimens, with the proximal pair of pinnules large and sometimes almost fully pinnate. *Pinnules* distinctly stalked, not adnate, oval to obovate in shape and sometimes rather rounded, not oblong or linear; margin irregularly toothed, teeth short and rather fat, mucronate. Tips of pinnules obtusely rounded and bearing short, mucronate teeth. *Sori* produced in great quantity, reddish-brown in colour, rather short, median in position. Spores abortive.

This new hybrid may, at a glance, be very easily confused with *A. adiantum-nigrum*, for the two plants have many gross features in common. Both have bipinnate to tripinnatifid fronds which are triangular in shape and in both the basal pinnae are conspicuous and well-developed. Another striking characteristic which they have in common is the triangular pinnae in which the proximal pinnules are large and subdivided, with the proximal basiscopic pinnule almost equalling the proximal acroscopic pinnule in size and development. This feature is entirely lacking from *A. billotii.* In this particular hybrid it is the ultimate divisions of the frond that show the influence of *A. billotii*, and the pinnules in the middle third of the frond should be examined carefully. These pinnules are rather crowded, sometimes overlapping, and, even towards the distal end of the pinna, are distinctly, although shortly, stalked. They are oval in shape, rounded at the tips and bear short, mucronate teeth. In *A. adiantum-nigrum* only the proximal pinnules are stalked, the distal ones being adnate to subsessile, obliquely inserted, and acute. The pinnules of this species are narrow, oblong in shape, never oval or lobed, and are distinctly longer than broad. The tips are usually pointed, and bear 3–5 tiny, very sharp, teeth.

In only two days, some ten different plants of this new hybrid were discovered, and it may turn out to be a plant of relatively common occurrence on Guernsey. At a glance, it is certainly easily mistaken for a state of *A. adiantum-nigrum*, and this possibly accounts for the fact that it has remained undetected until now. To date, this hybrid is known from only three localities on Guernsey, two from St. Peter-in-the-Wood (Les Pres, two plants: AS/1102, Type, and AS/1101, leg. H. Gabe, 23.4.71, and one specimen, s.n., north of Rue des Clercs, leg. D. McClintock & P. J. Girard, 25.4.71) and one from St. Saviour's (Reservoir, two plants: AS/1100, hedgebank near reservoir, leg. Anne Sleep, 22.4.71, and AS/1104, leg. B. Makin, 23.4.71). However, it is almost certain to occur elsewhere on the island, and it would be profitable to make a careful search in any of the hedgebanks where both *A. billotii* and *A. adiantum-nigrum* are growing together.

University of Leeds ANNE SLEEP

SPORE MORPHOLOGY OF THE *CYSTOPTERIS FRAGILIS* COMPLEX

A considerable amount has been written on the distribution of the two spore-types, echinate and rugose, hitherto described in the *Cystopteris fragilis* complex.[1] CRABBE, in Flora Europaea 1: 19 (1964) uses the spore morphology solely, to distinguish between *C. fragilis* L. and *C. dickieana* Sim (with *C. baenitzii* Dörfl.). During the summer of 1970 whilst holding a vacation studentship at the British Museum (Natural History), the junior author has had the opportunity to study the spores of a large number of specimens, from Britain and Europe generally, with the scanning electron microscope.

Specimens with echinate spores showed variation in breadth and length of spine; the walls forming the spines are very fragile and broken hollow spines are often seen. Tetraploid, hexaploid and octoploid cytotypes show spores of different sizes as reported by BLASDELL[2] (ranges: 32.42, 38.48, 43.53μm respectively),

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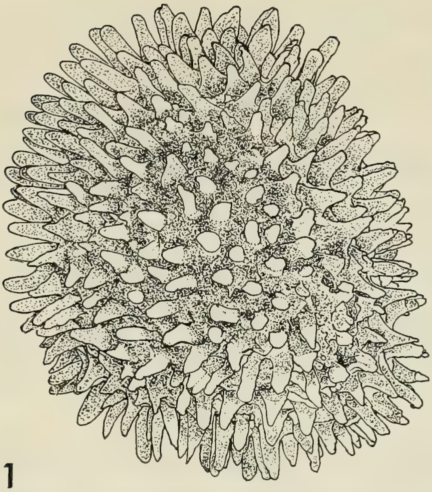
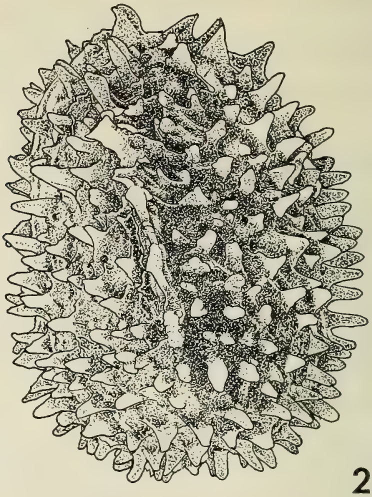
[1] ALSTON, A. H. G. 1951, *Am. Fern J.* **41**: 76–78; HAGENAH, D. 1961. *Rhodora* **63**: 181–193; LARSEN, K. 1952. *Bot. Tiddskr.* **49**: 39–44; WAGNER, W. H. 1955. *Rhodora* **57**: 219–240; WIGGINS, I. L. 1954. *Am. Fern. J.* **44**: 97–108; etc.

[2] BLASDELL, R. F. 1963, Mem. Torr. Bot. Club **21**: 1–102.



1



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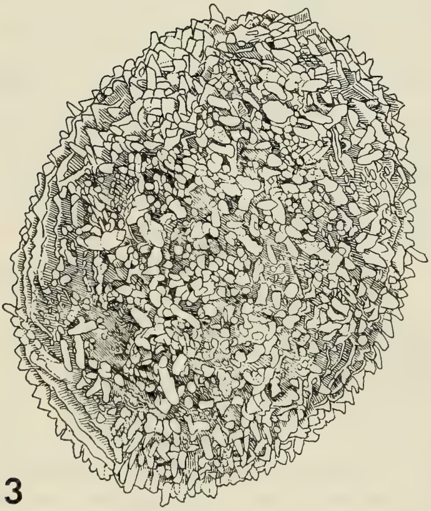

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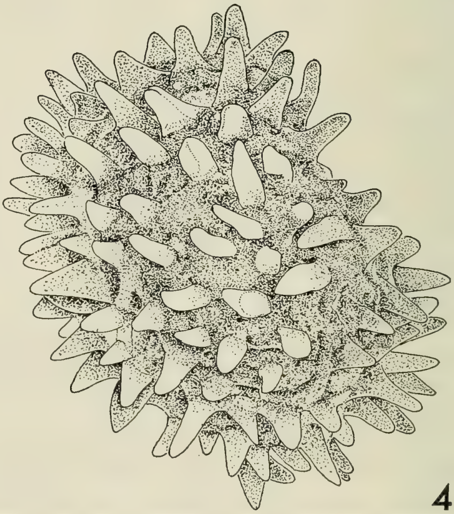

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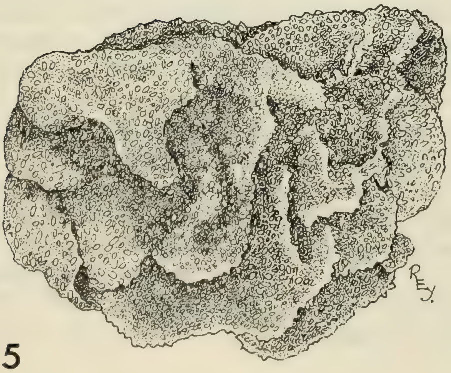

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FIGURES 1–5: Spore sculpturing in *Cystopteris fragilis* complex. Fig. **1:** *C. fragilis*, Trübsee, Switzerland, *Reichstein 1716*, octoploid. Fig. **2:** *C. regia*, Cimolais, Italy, *Reichstein 2776*, hexaploid. Fig. **3:** *C. dickieana*, Ardnamurchan, *Cannon & Kendrick 66*, ploidy unknown. Fig. **4:** *C. fragilis*, Arncliffe, Yorkshire, *Gerrans s.n.* tetraploid. Fig. **5:** *C. dickieana*, type locality, Kincardine, *Dickie s.n.*, tetraploid.

but they also exhibit a difference in density of spines, those of the octoploid being more numerous and much closer together. The surface of the spines was smooth or faintly striate. On spore size and ornamentation the majority of British specimens seen are of the hexaploid or octoploid type.

C. regia Desv., with finely dissected leaves, has spores with short, blunt spines (Fig. 2) and it is possible that spore ornamentation may help to separate this taxon. A hexaploid of *C. diaphana* (Bory) Blasdell (= ? *C. sempervirens* T. Moore) from the Canary Islands, has very dense, short spines suggesting that in this taxon spine density may also be correlated with ploidy.

It is clear that the rugosity exhibited by *C. dickieana* is an artifact of drying but a more detailed study of sections of spore wall may show properties of the intine or sexine which define lines of "support" which will give characteristic shrinkage patterns. *C. baenitzii* from Scandinavia always showed a more tightly folded outer wall than the almost winged or thickly folded *C. dickieana* from Kincardine.Three specimens from Scotland were found to have spheroid or ovoid spores with no wrinkles at all. Closer inspection of the fine surface patterns showed the granular nature as seen on more typically rugose spores. This granular surface was common to *dickieana*-type spores throughout its range. On one specimen from Glengarry, V.-C. 88, the few spores available showed an echinate spore with a granular, rather than smooth surface suggesting a hybrid pattern. Considerable abortion in the depauperate sporangia supported this hypothesis. The *dickieana*-type of spore redefined as that with a granular surface rather than rugose has now been found from Kincardine through Forfar and Pitlochry to Glen Loy and Ardnamurchan in Westerness. More specimens of *Cystopteris* throughout its range would be welcomed.

We must thank Professor T. Reichstein and Dr G. Vida for supplying cytologically controlled material, and Miss Roberta Young for the illustrations.

British Museum (Natural History) A. C. JERMY & LINDA HARPER

REVIEW

THE FLORA OF MONMOUTHSHIRE by A. E. Wade. 236*pp.* 2 *plates. National Museum of Wales, Cardiff,* 1970. *Price* £2.25

This is a first-rate county flora of the traditional type of an area favoured by fern lovers where future excursions may prove fruitful. Obviously the bulk of the work is given over to records of the 1,137 phanerogams but the Introductory chapters on botanical history, biogeography and geology are valuable.

Thirty-seven pteridophytes are recorded; nearly half are rare and should be conserved. It is surprising that *Asplenium trichomanes* subsp. *trichomanes* is unrecorded. *Osmunda regalis* and *Thelypteris palustris* are apparently extinct or becoming so. A recent B.P.S. record, and therefore not included, is *Polypodium* × *shivasiae* Rothm. (the hybrid between *P. australe* and *interjectum*) (J. W. Dyce, October 1970, near Tintern Abbey; BM & NMW). The observant botanist should look out for *Lycopodium selago*, *Equisetum sylvaticum*, *Asplenium marinum* and *A. viride* and report their occurrence to the National Museum, Cardiff.

A. C. JERMY

REVIEW

PACIFIC NORTHWEST FERNS AND THEIR ALLIES by T. M. C. Taylor. 247*pp, each* (97) *species with line-drawing and map. University of Toronto Press.* 1970. *Price* $15.00.

It is always pleasing to welcome a new regional fern flora — and especially when the author writes with the authority of some forty years of interest in the subject behind him. Professor Taylor has not only studied the ferns of his area in the herbarium but also in the field and his book with its copious illustrations are aimed as much at the field and experimental worker as at the herbarium taxonomist. The illustrations are not sometimes as detailed as perhaps they should be, e.g. in *Dryopteris austriaca, Woodsia ilvensis* and *Gymnocarpium dryopteris.* It is possible that the artist has never seen her drawings reproduced before; it is difficult to attain that compromise between scientific recording and artistic presentation.

The text is typographically very clear and attractive to the eye, although some numbering of the maps and figures would have been useful. It is possible to have a figure of one species, an unlabelled map of a second facing it and the text of a third tailing off the page. The maps are extremely useful and the American distribution detailed. In order to show up the interesting problems a more detailed distribution outside America would have been worthwhile rather than vague terms like 'Eurasia' which can be misleading.

Professor Taylor seems to be unaware of the relative researches in Europe on N. American species of *Asplenium* and *Polystichum* for instance. There could have been mention of Lovis's treatment of *Asplenium trichomanes* (Nature **203**: 324-325; Brit. Fern Gaz. **9**: 147; 1964).

Meyer's putative hybrid between *Polystichum braunii* and *P. lonchitis* as reported on p. 175 was in fact *P.* × *illyricum* (*P. aculeatum* × *lonchitis*). The correct hybrid has since been found and described under the name of *P.* × *meyeri* by Sleep & Reichstein (Bauhinia **3**: 299-374). *Dryopteris assimilis* could also have been better treated.

The arrangement of species is alphabetical under first family, then genus; we found it very bewildering, although possibly such arrangement is useful to some.

The Appendices are especially useful although perhaps Japanese chromosome counts could have been included. In Appendix II *Polypodium virginianum* and *Adiantum pedatum* are *not* endemic to N. America (although on p. 95 the author does state the latter grows in NE Asia). *P. virginianum* most certainly occurs in Japan.

In spite of these errors the book is absorbing and extremely useful, one which is indispensable to pteridologists interested in temperate ferns. For the fern grower it points to a number of species worthy of cultivation in English gardens. To the systematist it shows the need for team work in studying circumboreal ferns.

I am indebted to Dr Anne Sleep for discussing this book in relation to her Japanese fern studies.

A. C. JERMY

THE BPS EXCURSION TO SILVERDALE, LANCS

J. W. DYCE

This year the limestones of the North of England called us once again, to a little corner on the coast of Morecambe Bay, cut off from the Lakeland mountains on the north by the estuary of the River Kent. The district looms large in the early history of the Society, and several well-known fern finds were made here, notably that magnificent fern *Phyllitis scolopendrium* 'Crispa Nobilis Bolton' from Warton Crag. Many of our founder members lived in or near the area and it is worthy of note that one of the best known, Mr J. M. Barnes, lived adjacent to our hotel in Arnside, the Inglemere. It is appropriate that our only large specialist fern nursery in the country today, that of Reginald Kaye, should be here in Silverdale and during the week it became very much our second centre where we enjoyed many a refreshing cup of tea in the hospitable home of the Kayes. With him as our leader, Reg Kaye's knowledge of the area assured us of finding the best ferny places, and during a meeting on the Saturday evening of our arrival he mapped out his plans for the week most of which was to be spent on the limestones, chiefly on the overgrown limestone pavements which abound in the area, in marked contrast to the bare pavements in the Craven district further east. A total of 20 members and 2 visitors attended for all or part of the week, 29 August—5 September 1970.*

On Sunday morning Eaves Wood, a National Trust property, was visited. This wood is typical of the region, the trees growing from the crevices of the pavement which in some places was uncovered, in others overgrown by dwarf vegetation among the trees and quite impenetrable. A common tree was the Yew, *Taxus baccata.* Ferns abounded except in the places of dense shade, although even there the ubiquitous *Phyllitis scolopendrium* seemed to be quite happy. This fern is the one we associate most with the whole locality, and it provided us with a variety of forms, narrow, wide, undulate, large and small, but in spite of their abundance very few outside their normal range of variation and worth collecting. With thoughts of 'Crispums' in our minds we hunted assiduously wherever we went during the week, but it seemed that Reg Kaye and the hunters of old had done their job only too well and left us nothing! Only 10 species were recorded from Eaves Wood, the common one being *P. scolopendrium.* The only two Spleenworts were *Asplenium ruta-muraria* and *A. trichomanes*, *Dryopteris* was represented by *D. austriaca*, *D. filix-mas* and *D. pseudomas*, and we saw both *Polypodium interjectum* and *P. vulgare* sensu stricto, *Pteridium aquilinum* and quite a lot of *Polystichum aculeatum.* Outside the wood on a nearby railway bridge *Cystopteris fragilis* was growing vigorously, re-establishing a pre-1930 record for the district. For the variety hunters our entry into the wood seemed propitious, for a good crested specimen of both *D. filix-mas* and *P. scolopendrium* were quickly found, but alas! the promise of those finds was not upheld. Mr Kaye has in the past found *Ceterach officinarum* on a wall at the edge of the wood but we did not see it.

At mid-day we were joined by Mrs Jones Parry, the plant recorder for the district, and in the afternoon she led us to Hawes Water, a very still stretch of water closed in by scrub making it rather inaccessible, and noted for an absence of bird-life due, we were told, to a scarcity of animal life in the water making very little feeding available for them. Ferns were also scarce, only 7 species and 2 horsetails, *Equisetum arvense* and *E. palustre*, being seen. To the ferns recorded during the morning we were able to add *Athyrium filix-femina*, growing very sparingly. We did not linger long at Hawes Water and moved on to Throwbarrow Quarry, a mile or so distant on the high ground to the south. Ferns were plentiful again although only 9 species were noted, including most of those already seen with the addition of a few plants of *Polystichum setiferum*. The quarry is a large one, very old, and geologically most interesting with perpendicular faulting resulting in smooth completely flat upright rock walls in which are embedded innumerable fossils. Outside and along its western rim is a long deep ravine, overhung with trees and full of ferns, again chiefly *P. scolopendrium*. It is interesting to note that this ravine was excavated by the local inhabitants to hide their cattle in the old days of the cattle raids into England by the Border Scots, and an admirable hiding place it must have been, even though it was the Scot in our party (myself) who stumbled upon it and explored it!

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*Members—Miss M. E. Butterfield, H. J. Bruty, Mrs M. L. Castellan, J. K. Cramp, J. W. Dyce, Dr R. A. Finch, G. Gilbert, F. Jackson, Mrs M. Kaye, R. Kaye, Miss M. M. Kingston, B. Makin, J. W. Merryweather, Miss T. J. Moore, Mrs M. T. Petch, S. R. Piggin, H. L. Schollick, Mrs M. W. Schollick, A. J. Worland and M. R. Worland. Visitors—Miss W. Baines and S. Hill.

On Monday we spent the day on Warton Crag hoping that its past reputation would be upheld. It was a happy hunting ground for the early fern men, and it was in the early years of the present century that it presented them with the frilled Hartstongue Crispa Nobilis Bolton' which I have already mentioned. In the morning we approached the Crag from the east side and climbed to the top through woodland, bracken moor and limestone pavement in some places overgrown by trees and shrubs. The Hartstongue predominated in the pavement crevices or grikes and was the fern which attracted us most but nothing exceptional was seen. In all, 15 fern species were noted including *A. ruta-muraria*, *A. trichomanes*, *Cystopteris fragilis*, *Polypodium interjectum*, *P. vulgare*, and the more uncommon *Gymnocarpium robertianum*, *Dryopteris villarii* and *Ophioglossum vulgatum*. We also recorded. *A. filix-femina*, *D. austriaca*, *D. filix-mas*, *D. pseudomas* and *P. aculeatum*. The *D. villarii* and *G. robertianum* were only small colonies in the grikes on the highest part of the Crag, and *O. vulgatum* a few plants only among the grass in some open woodland a little lower down. In the afternoon we travelled round to the west side and again penetrated towards the high ground but did not add any more species to the morning's list. Most of us spent a long time in an extensive forest of Yew trees on pavement where the *P. scolopendrium* provided interesting hunting, but again it was all quite normal. However, in such a large area a day's hunting can only cover a small part of the ground, so Warton Crag is still very probably secreting some good fern varieties.

In the same kind of country but further to the north beyond the Kent Estuary and approaching the Lake District, we explored Whitbarrow on the Tuesday. This was also a well-known hunting ground in the past and many good varieties have originated there. We climbed it on the east side by a rough track leading to the top from Rawsons Farm, and we were able to take up some of the cars which saved time for a longer period of search on the undulating top at an altitude of 500/600 feet with woodland, grass slopes and limestone pavement and scars. It was exposed terrain, as we found when heavy rain descended and drove us to shelter. One of our first finds was a heavily crested Lady Fern which, like our early variety finds in Eaves Wood, seemed a promising sign which again came to nought. Fern species were numerous — 20 in all — and the limestone ones were common, *A. ruta-muraria*, *A. trichomanes* and *A. viride* being noted, as well as *C. officinarum*, *C. fragilis*, *P. scolopendrium* and some Polypodies which we were unable to determine exactly. On the slopes in outcrops of limestone *D. villarii* and *G. robertianum* flourished, with *P. aculeatum* in the deeper grikes, in shady places some drifts of *Phegopteris connectilis* were noted, and in the open grassland where the lime must have been leached away *Blechnum spicant* grew, as well as *Oreopteris limbosperma* and *Pteridium aquilinum*. Among the bushes and trees and in the open *Athyrium filix-femina* was fairly widespread, along with *Dryopteris assimilis*, *D. austriaca*, *D. filix-mas* and *D. pseudomas*. We even found some *D. carthusiana*.

The top of Whitbarrow is extensive and we could cover only a small part of the ground, but so attractive was it that we returned again on the Friday, this time on the north side, using the network of tracks to get the cars up to an old quarry, well up into our hunting ground. The quarry was an excellent habitat for several ferns. *A. ruta-muraria*, *A. trichomanes*, *C. officinarum*, *C. fragilis*, *D. villarii*, *G. robertianum*, *P. scolopendrium*, *P. interjectum* and *P. vulgare*. This part of Whitbarrow is well wooded over large areas with some stretches of open moorland covered with *P. aquilinum* and some *O. limbosperma*. In the woods *A. filix-femina*, *D. austriaca*, *D. filix-mas* and *D. pseudomas* grew extensively and two colonies of *O. vulgatum* were found. In the many limestone outcrops all the limestone ferns were common with *P. aculeatum* flourishing in the grikes, and on the higher parts *A. viride* was plentiful. We recorded 18 species from this northern part of Whitbarrow, and a feature of the locality was the abundance of *C. officinarum* in all the patches of broken limestone. We also noted some tall-growing *D. villarii* and a few plants were collected for study purposes.

To return to our first Whitbarrow visit on Tuesday, we descended from the top after lunch and travelled round to the east side by Witherslack Hall. Here below Whitbarrow Scar there is extensive private woodland in which we had permission to hunt, as well as in the Hall grounds with a lake round which several large colonies of *Matteucia struthiopteris* grew in boggy ground. We would have expected to find *D. carthusiana* here, but did not, although we found it later in the afternoon in the woods which were damp and fostered the growth of the larger ferns *A. filix-femina*, *D. austriaca*, *D. filix-mas* and *P. aquilinum*, also *B. spicant* and *P. scolopendrium* with some *Phegopteris connectilis*, and in the more open parts *Oreopteris limbosperma*. On walls near the farm buildings *A. trichomanes*, *C. officinarum*, *C. fragilis* and *P. vulgare* grew and on a slope nearby were a few plants of *P. aculeatum*. One horsetail, *E. arvense*, was also seen. Close to some of the old disused buildings, a plant of a good *P. aculeatum* 'Acutilobum' was found, obviously a garden throw-out, and not far away a Hartstongue with wide lacerated fronds suggestive of the variety 'Fimbriata' was collected. A good *P. vulgare* 'Semilacerum' was also found and collected.

For the benefit of members who were unacquainted with the extensive limestone pavement on Hutton Roof Crags and its rich fern flora we planned a visit there on the Wednesday. Starting off in pouring rain in the hope, which did not materialise, that the weather would clear, we found conditions on the high exposed pavement most unpleasant and heavy driving rain soon compelled us to retreat. We dried off somewhat in a village inn during lunch and in the afternoon drove west again, to the Roudsea Wood Nature Reserve a few miles beyond Grange-over-Sands. Although still showery it was sheltered here, and with the warden, Mr Carr, we made an extensive tour of this wet woodland which is full of ferns, 18 species but only one horsetail, *E. arvense*, being recorded. On our previous visit several years ago there was only one plant of *Osmunda regalis* in the Reserve, but since then a second plant has established itself on the side of one of the drainage ditches, much to the satisfaction of Mr Carr who hopes the fern will continue to spread. One of the most common ferns is *D. carthusiana*, and where we had previously recorded many plants in the *D. austriaca* × *carthusiana* complex, we were now able to confirm that many of them are in fact *D. assimilis.* Most of the ferns are the large woodland kinds *A filix-femina*, *D. austriaca*, *D. filix-mas* and *D. pseudomas*, with some *B. spicant*, *O. limbosperma* and *P. aculeatum*, and of course, *P. aquilinum* in abundance. In a few places we noted some *A. ruta-muraria*, *A. trichomanes*, *P. scolopendrium*, *P. vulgare* and *P. connectilis*, but one of the chief fern attractions of the Reserve is the small open area in which *Botrychium lunaria* and *O. vulgatum* grow happily.

So far we had overlooked our "home" ground around Silverdale, and this was remedied on Thursday. We started the day in Burtons Wood at Bottoms where some years ago Mr Kaye found a good *P. setiferum* 'Manica Infantis'. Most of the wood is overgrown limestone pavement and provided a morning of very interesting hunting during which 12 species were recorded. Our search commenced with the finding of several crested Male Ferns thrown out from some garden, but among them was the very fine variety 'Martindale' which was collected. The wood is on sloping ground and at the bottom was a wet meadow where among the *D. filix-mas* growing in the boundary hedge some indifferently crested plants were seen. Near here we also found a few plants of *O. vulgatum* — Mr Kaye has previously found *B. lunaria* in this spot, but this fern was not to be seen while he had not previously spotted the *Ophioglossum*! Inside the wood *D. austriaca*, *D. filix-mas* and *D. pseudomas* flourished, as well as *P. aculeatum* and *P. setiferum*. On drystone walls we noted *A. ruta-muraria*, *A. trichomanes*, *P. interjectum* and some *C. officinarum*, but the dominant fern here, as elsewhere, was *P. scolopendrium*, filling the grikes with lush growth. Still in search of good varieties we scoured the wood pretty thoroughly and one good Hartstongue find was made, a marginate form with regularly frilled edges.

In the afternoon some of our party joined Mrs Jones Parry to visit the habitat of some orchids while the rest of us explored some woodland on the coast at Burrows Farm. Only 9 species were recorded, all the more common ones but none, not even *P. scolopendrium*, in abundance. One small patch of crested *A. filix-femina* was seen but all the plants were poor ones. The poor hunting encouraged an early finish, the more so since Mr Kaye's nursery was close by and we never tired of seeing the plants there, particularly the many interesting fern varieties. Borders are full of them, Lady Ferns, Male Ferns and Polystichums. One is devoted to Polypodies in great variety, and this year new raised borders have been filled with a large selection of some of the best of today's fern varieties. On the walls in the nursery small ferns abound, including some very fine *A. trichomanes* 'Cristatum', and many self-sown Hartstongues. One of Mr Kaye's best Hartstongue varieties, *P. scolopendrium* 'Kaye's Lacerata' was found as a self-sown seedling in one of the nursery walls some years ago. In the plunge beds are many hundreds of young first-rate varieties, some of them entirely new and of great promise.

During the week, the nursery was a lodestone which drew us on many days when hunting was finished, but perhaps the generous refreshing pots of tea provided by Mrs Kaye, which were much appreciated, had something to do with it! Mr Kaye is an expert plant photographer and an enjoyable evening was spent at their home when he exhibited colour slides of ferns, lichens and other plants. On another similar evening at the home of Mrs Jones Parry we were shown some of her magnificent collection of slides of British plants. We would express our gratitude to these friends for their hospitality which contributed greatly to the enjoyment of our week in Silverdale.

In the following list of ferns seen during the week, figures 1-12 (**bold**=new record, *=confirmation of pre-1930 record, for the *Atlas of the British Flora*) refer to localities:

Asplenium ruta-muraria—1,2,3,4,5,6,7,8,9,10,11
A. trichomanes—1,2,3,4,6,7,8,9,10,11,12
A. viride—10,11
Athyrium filix-femina—2,5,6,7,8,9,10,11,12
Blechnum spicant—9,10,12
Botrychium lunaria—9
Ceterach officinarum—1,3,10*,11*,12*
Cystopteris fragilis—4*,7*,**10,11,12**
Dryopteris assimilis—**9,10**
D.austriaca—2,3,4,5,6,7,8,9,10,11,12
D. carthusiana—9,10*,12*
D. filix-mas—1,2,3,4,5,6,7,8,9,10,11,12
D. pseudomas—2,3,4,6,7,8,9,10,11
D. villarii—7,10,11
Equisetum arvense—5,9,12
E. palustre—**5**
Gymnocarpium robertianum—7,10,11
Ophioglossum vulgatum—3,7,9,**11**
Oreopteris limbosperma—9, **10,11,12**
Osmunda regalis—9
Phegopteris connectilis—9,10,12
Phyllitis scolopendrium—1,2,3,4,5,6,7,8,9,10,11,12
Polypodium interjectum—2,3,4,7,8,11
P. vulgare—4,7,8,9,11,12
Polystichum aculeatum—3,4,5,7,9,10,11,12
P. setiferum—3,6
Pteridium aquilinum—2,3,4,5,6,7,8,9,10,11,12

	Date visited Aug./Sept.	National Grid ref.
V.C. 60 West Lancashire (*O.S.* 1 *in. map ser.* 7 *sheet* 89)		
1 Arnside	29–5	34/4578
2 Burrows Farm Wood	3	4573
3 Burton Wood	3	4675, 4775
4 Eaves Wood	30	4676, 4776
5 Hawes Water	30	4776
6 Trowbarrow Quarry	30	4875, 4876
7 Warton Crag, east side	31	4972, 4973
8 Warton Crag, west side	31	4873
V.C. 69 Westmorland and North Lancashire (*O.S.* 1 *in. map ser.* 7 *sheet* 89)		
9 Roudsea Wood Nature Reserve	2	3281, 3282, 3381, 3382
10 Whitbarrow, east side	1	4586
11 Whitbarrow, north side	4	4487, 4587
12 Witherslack Hall	1	4386

REVIEWS

FERNS FOR GARDEN AND GREENHOUSE by Philip Swindells, 86 *pages,* 16 *black-and-white half-tone pictures. Dent, London,* 25 *March* 1971. *Price* £1.80.
The author is a grower, so this is a practical guide based on his own experiences. The arrangement is pleasing and realistic: after an introduction to ferns we are told about cultivation, propagation and pests and diseases; then the ferns are presented in habitats — shade, moisture, rock garden, cool and warm greenhouse; concluding with lists of fern societies and fern nurseries, a glossary and an index. The photographs, 2 by the author and 14 by P. R. Chapman, are nice studies.

It is a pity that the title of the book is exactly the same as that of another book by A. J. Macself published by Collingridge in 1952. The dust-jacket claim to give expert information on "all" the species likely to be considered for cultivation is unnecessarily optimistic. There is inconsistency in the method of citation of the plant names; sometimes it is in polynomial latin, sometimes in cultivar form, sometimes a mixture of both, and sometimes differently between text and index; but this question of status, botanical or horticultural, and of interpretation of the codes of nomenclature, is something which, fern-wise at least, is often confused and is in need of straightening out.

Despite these blemishes, here at a realistic price is an excellent handbook.

J. A. CRABBE

HANDBOOK ON FERNS, Special edition of Plants and Gardens vol. 25 *no.* 1. *Pp.* 77, 116 *illustrations* (59 *black-and-white,* 53 *coloured,* 4 *line-drawings*). *Brooklyn Botanic Garden, New York* 11225, 1969. *Price* $1.25.
Although this is primarily for North American growers, it is nice for the rest of us to know about some of their native ferns and habitats which we might be very glad to try to cultivate in our own countries. Here is a veritable mine of information covering so many aspects of fern growing in the short compass of its 77 pages that it forms a text-book. We are told how to grow from spores, of tropical and temperate species, for gardens from rockery to landscape, together with descriptions of splendid natural ferny scenes, and glossaries and bibliographies.

I would have preferred to have the trinomials (pp 16, 22, 23) accorded botanical or cultivar rank, "felix" (p 9) is a common mistake for filix, and I think *Athyrium iseanum* (pp 39, 46) should be *A. niponicum.*

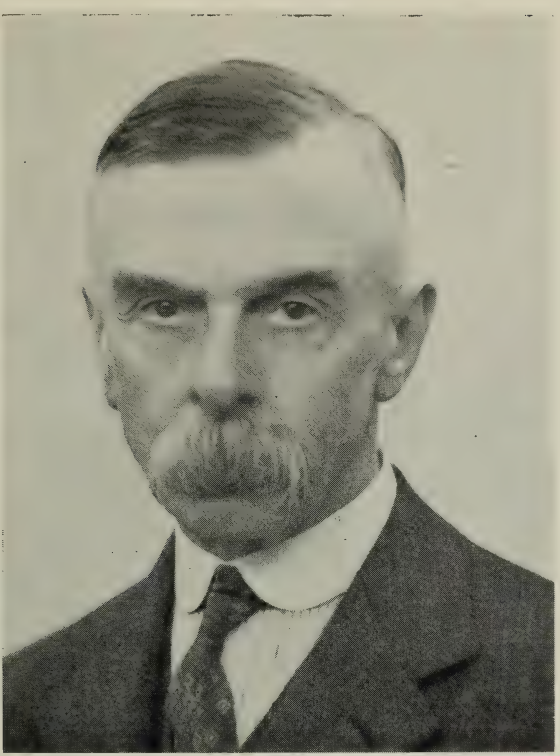
But these are very minor points, and this book is altogether a sheer delight for the fern enthusiast.

J. A. CRABBE

PLANT VARIATION AND EVOLUTION by David Briggs and Max Walters. 256*pp. World University Library*[7] *Weidenfeld and Nicolson, London,* 1969. *Price* £1.75 (*hardback*) 90*p* (*paperback*)
This little book is such excellent background reading for anyone interested in the evolution of plants that I would thoroughly recommend it. It is written as a textbook for the student botanist but can be picked up by the amateur botanist who will find in it a wealth of readable information. The historical chapters are particularly good as are those on hybridisation and polyploidy (in which the *Polypodium* story is treated fully). The reader is told in the last chapter how to take the subject further.

A. C. JERMY

OBITUARY



PERCY GREENFIELD (1880-1970)

Percy Greenfield, the Society's Grand Old Man, died on 8th December 1970 at the age of 90. With him goes our last link with the old fern hunters who founded the Society and did so much to preserve the fine fern varieties.

Greenfield was the son-in-law of Dr F. W. Stansfield, marrying Elsie, his eldest daughter in 1914. He could not have had a better mentor than 'the Doctor' and he profited greatly from the close association, acquiring a vast knowledge of ferns. But in many ways P.G. was a diffident man and it is to be regretted that he, like his father-in-law, never committed his knowledge to paper apart from sundry articles in the *Gazette*. In the field he was an ideal companion, particularly in the West Country which he loved, among his favourite ferns the Polystichums. My great love of these stems from the many happy weeks I have spent with him over the years in Devon lanes, absorbing his knowledge and getting to know so much about the finer points of fern variation. He was always happy sharing his knowledge with others.

P.G. spent his early boyhood in Kent, winning a scholarship to the Mathematical School at Rochester. Later, his parents moved to the Isle of Wight where he completed his education at Newport Grammar School and at the age of 15 was the winner of the Queen's Prize, presented by Queen Victoria to the Dux of the school. He entered the General Post Office branch of the Civil Service at the age of 18, and when he retired at the age of 60 was Overseer of the U.S.A. and Canadian Division of the Foreign Section. Senior officers in the Foreign Division of the

Post Office—in Greenfield's day, very junior officials—still remember him with affection and respect. He was beloved by his staff, was efficient, quiet and never lost his temper, he inspired and led and set a wonderful example to young men later given positions of authority.

As a young man, P.G. did not enjoy robust health but was, nevertheless, a very keen tennis player. He had a passion for mountains and climbed in the Lake District, Scotland and in the Alps with two friends until the tragic death of one of them during one of their Alpine climbs. He climbed Ben Lawers when he was 69 although we now know that he had probably already had a coronary thrombosis at that time, and in 1957 at the age of 77 he climbed with me to the top of Ingleborough, starting from the south side of the mountain at Ingleton and not stopping for a single rest during the climb. His other great love was music, his knowledge of its history and theory being enormous, and he was a very fine player of both piano and organ. His touch on the keyboard was still unimpaired during the last few years of his life and his interpretation of the works of Mozart and other great composers was something to be enjoyed. His acute intellect did not neglect the sciences, of which he had a wide all-round knowledge. Astronomy was a favourite study and some of his annotated text-books on the subject, now in my possession, show clearly the deep working of his probing mind.

P.G. joined our Society in 1920 and for about 50 years was active in its affairs. He took over the secretaryship after his father-in-law's death in 1937 until early 1948 and his work did much to ensure its survival. Until a short time before his death his interest in its welfare continued unabated. He was awarded the Society's Stansfield Memorial Medal in 1951 in recognition of his great services and in 1963 was made an Honorary Member. He was also a Vice-President of the society.

I enjoyed the close friendship of P.G. for more than 20 years and had ample opportunity to find out the sterling qualities of the man. He passed on to me his great love of ferns and of the Society, and it is very largely due to his encouragement and guidance that I have been able to devote myself so whole-heartedly to its service. His death is a great loss to the Society, and it is with a very deep sense of personal loss that I mourn his passing. J. W. DYCE

TOMITARO NAMEGATA

It is with great regret we announce the death on 26 March 1970 of Mr Namegata, the Secretary and President of the Nippon Fernist Club. A full notice will appear in the next issue of the B.P.S. *Newsletter.*

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Printed by the Devonshire Press, Torquay, England

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THE BRITISH FERN GAZETTE

VOLUME TEN PART FIVE

1972

THE JOURNAL OF THE
BRITISH PTERIDOLOGICAL SOCIETY

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DRYOPTERIS CAUCASICA – AN ANCESTRAL DIPLOID IN THE MALE FERN AGGREGATE

C.R. FRASER-JENKINS* & H.V. CORLEY**

ABSTRACT

The combination *Dryopteris caucasica* is made, based on *Aspidium caucasicum* A. Braun 1841, which was a substitute name for Fischer & Meyer's illegitimate *A. affine* of 1838. *D. caucasica* is described, and regarded as the other parent, with *D. abbreviata*, of *D. filix-mas*. Three hybrids are newly recognised: **D. x euxinensis** (*caucasica* x *filix-mas*), **D. x initialis** (*abbreviata* x *caucasica*) and **D. x mantoniae** (*abbreviata* x *filix-mas*).

INTRODUCTION

It has long been known that *Dryopteris filix-mas* sensu lato includes a number of more or less closely related species in Europe and Western Asia. More recently since the work of Professor I. MANTON (1950) it has been possible to separate from the group an apogamously reproducing species or aggregate of species variously described as *Dryopteris borreri* Newman, *D. pseudomas* (Wollaston) Holub and Pouzar, *D. mediterranea* Fomin and *D. paleacea* (Moore) Fomin etc. The classification of this complex group, which could be mainly of hybrid origin, may yet present further problems.

The two remaining taxa are both sexually reproducing and are the tetraploid *D. filix-mas* (L.) Schott sensu stricto, and the diploid *D. abbreviata* (DC.) Newm. (including *D. oreades* Fomin and *D. coreanomontana* Nakai). MANTON (l.c.) by the cytological examination of hybrids (artificially made) between the two and by the subsequent production of an apogamously induced diploid of *D. filix-mas*, showed that *D. filix-mas* is an allotetraploid species to which *D. abbreviata* is part parental. The other ancestral diploid in this complex remained unidentified although many of its morphological features can be deduced from a study of *D. filix-mas* and *D. abbreviata.* The discovery, by C.R.F.-J., of a *Dryopteris* with an unusual morphology in Turkey in 1968 was therefore of considerable interest. The plant, however, received a severe set-back and was nearly lost, and it was not until 1970, when another expedition to Turkey was mounted, that more thorough examination of this and several other similar populations could be made.

As a result of further study and botanical expeditions to Turkey and the Caucasus it now appears that plants of this nature constitute the missing ancestral diploid species in the *Dryopteris filix-mas* aggregate.

NOMENCLATURE, TYPIFICATION AND DESCRIPTION

Dryopteris caucasica is not new to science but has been overlooked by present-day workers. It was described as *Aspidium affine* by Fischer & Meyer (in Hohenacker, 1838). This name was illegitimate having been used previously (1828) by Blume for another entirely different taxon. In 1841 Alexander BRAUN corrected the situation by citing the Fischer & Meyer description and using a new specific epithet, which is now transferred to the genus *Dryopteris* by the present authors.

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* The University, Leicester; now at Charterhouse School, Godalming, Surrey.

** Pucketty Farm, Faringdon, Berks.

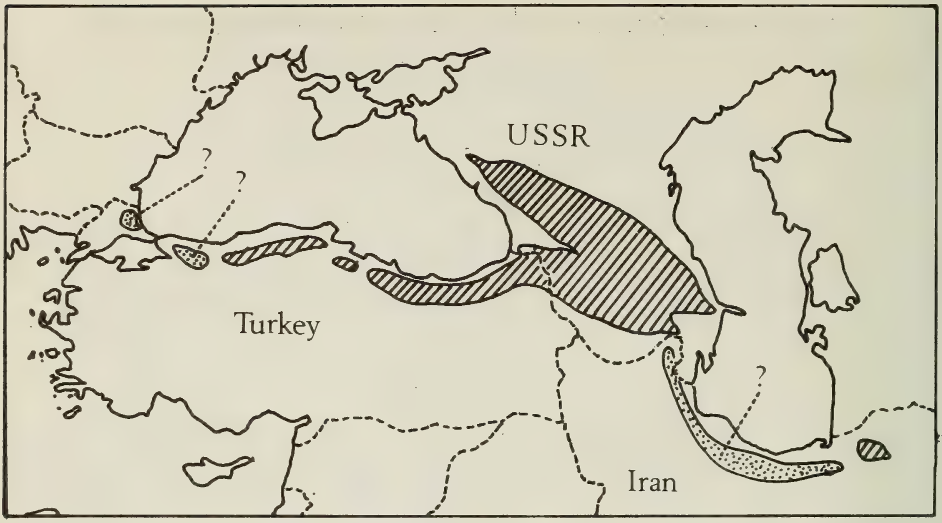

FIGURE 1: Distribution of *Dryopteris caucasica* (cross hatching); stippled areas = doubtful occurrence.

Dryopteris caucasica (A. Br.) Fraser-Jenkins & Corley **comb. nov.**

Basionym: *Aspidium caucasicum* A. Br., *Flora* 24:707 (7 Dec 1841) nom. nov., type as for *A. affine.*

Synonym: *Aspidium affine* Fisch. & Meyer ex Hohenacker, *Bull. Soc. Nat. Moscou* 11:240 (1838); non Blume nec Wall. (1828). Type: Khanlar, Azerbaydzhan S.S.R., *Hohenacker,* 1836; LE! (See below).

Dryopteris filix-mas (L.) Schott var. *athyriformis* Fomin, Vest. Tiflis. Bot. Sada 20:35 (1911). Syntypes from Prov. Terek and Tiflis (TBI!).

Typification.

In material loaned to us from the Botanical Institute, Leningrad, a specimen labelled: *"Aspidium affine, Helenendorf, Acc. a D. Hohenacker 1836"*, in Meyer's handwriting appeared to be a good candidate for the holotype. It is probably part of Hohenacker's collection which was published under the name of *Aspidium filix-mas* collected "In provincia Karabach et in territorio Elizabethopolensi" (HOHENACKER 1833, p.260) and

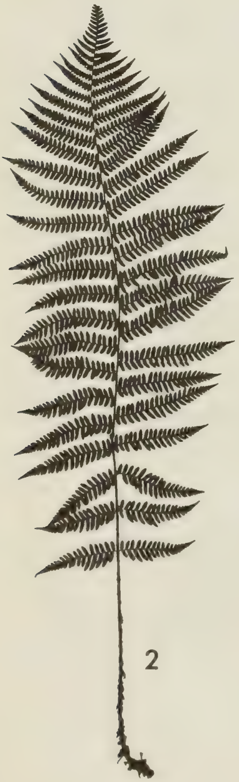

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FIGURE 2: Silhouette of frond of *D. caucasica,* X $\frac{1}{8}$; *CRFJ 2854,* Ritsa, Abkhazia, U.S.S.R.

which Hochenacker mentions in Fischer and Meyer's description published by him in 1838. Helenendorf is the old name for Khanlar, a village 8km south of Kirovabad.

This is the only specimen we have been able to discover which was definitely known by Fischer and Meyer at the time they wrote their description. Not only was it labelled by Meyer in 1836 'Received from Hohenacker', but it also bears another label in Meyer's handwriting which gives a diagnostic description similar to that published in Hohenacker (1838). A.E. Bobrov of Leningrad states (pers. comm.) that there is also a second exact duplicate of the holotype specimen in herb. LE.

Material collected by Hohenacker in Herb. Boissier, Geneva, which A.H.G. Alston has labelled as 'Type Specimen', has no date or precise locality, and it is far from certain that Fischer and Meyer used it as a basis for their description.

Description.

Plant of graceful habit, very variable. *Rhizome* up to 35 X 10cm; apex erect and clothed in lanceolate, concolorous, brown scales; older parts procumbent and usually unbranched. *Fronds* up to 105cm long, eglandular in all parts, in an erecto-patent rosette, frost-sensitive and not persistent in winter. *Petiole* (1/6–) 1/4–1/2 as long as blade, very pale yellowish green or whitish when mature, sparsely clothed with concolorous, brown, lanceolate to linear-lanceolate scales up to 2cm long, which become toothed at the margin towards the attenuate apex; rhachis similar with scales becoming paler and hair-like towards apex. *Lamina* up to 80 X 35cm, ovate-lanceolate to elliptic, occasionally truncate at base, flat, soft in texture, usually pale green with the lower surface even paler, bipinnate. *Pinnae* up to 20 X 5cm, lanceolate or frequently elliptic with attenuated apex, often asymmetrical, the basiscopic pinnules being longer, pinnate below, pinnatisect higher up. *Pinnules* narrowly lanceolate, truncate at base, apex acute; the lowermost shortly stipitate with winged stalks, the basal pair often shorter than the pair above. Median pinnules sessile, usually much the longest, the basiscopic more so than the acroscopic; margins deeply lobed to almost entire, lobes truncate with 2–5 acute teeth; the lowest basiscopic lobe of the lowest basiscopic pinnule somewhat larger, with up to 10 teeth, but not forming a large auricle as in *D. abbreviata*; teeth very acute and distinct at pinnule apices. *Stomata** 44–50μm. *Sori* (2–) 4–9 pairs on each pinnule; indusia 1–2mm diameter, flat, circular or somewhat extended at one side, very thin and membranous, white, without chloroplasts, eglandular, greatly overlapping the sporangia before shrinking to a small size, edges lacerate. *Spores* (30.8–) 33.0 (–37.2) X (19.9–) 22.6 (–25.3) μm** brown, verrucate with very short ridges 2–4μm tall, densely scattered over the surface; ripe June to August.

Sexual diploid, 2n=82. *Habitat* in forests and forest clearings with high rainfall, usually above 750mm per annum; from 700 to 2,700m altitude, dying out above the forest belt.

Geographical range (Fig. 1): Black Sea coast of Turkey, the Caucasus Mts and Transcaucasia, and the southern Caspian forest area of Iran. It has not been possible to include here a map of the range of *D. abbreviata*, but it may be said that the two ferns share a large area where they both occur, and there is every reason to suppose that hybridization is still taking place between them.

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* Tissue bleached in sodium hypochlorite solution and mounted in water; 20 stomata measured from median pinnule of median pinna of specimens from each locality.

** Inner wall of spore measured dry; average of 20 from each locality.

Variation: *D. caucasica* displays a wide range of variation, partly as a response to conditions of shelter and moisture. In Turkey, at least, specimens growing in very sheltered and luxuriant conditions were seen to attain an elegant foliose form with very wide pinnae, the median pinnules greatly developed and overlapping those of the next pinna. Such specimens also have very markedly asymmetric pinnae, the basiscopic pinnules being much the longest. However, in cultivation in more open conditions in Britain these features were lost.

The depth of lobing of the pinnules also varies greatly, as does the length of the pinnule teeth, both being less in more exposed habitats.

Other features remain constant almost without exception, notably the acuteness of the pinnule teeth, the flatness and thinness of the indusium, and, when fully developed, the small size and ornamentation of the spores.

The table on p. 228 emphasizes features of distinction between *D. caucasica* and the species most likely to be confused with it. It is noticeable that, when comparing it with *D. abbreviata* and *D. filix-mas*, its morphology is more or less what would be expected for the other parent of the latter. As the *D. villarii/pallida* complex has been suggested as containing the other parent of *D. filix-mas* (WIDÉN et al. 1971), we include data on the morphology of that group in the table. Other herbarium specimens seen include the following (collected by C.R.F.-J. unless otherwise stated):

TURKEY

Bolu: W side of Bolu Daği, above Kaynaşli, 18km west of Bolu, *Rhododendron* scrub, 900m alt., 18 Aug. 1970, *2081, 2082* (BM and herb. CRFJ); c.5km W of Yeniçağa, *Quercus/Carpinus* scrub, 13 Sept. 1970, *2409* (BM and herb. CRFJ). Trabzon: 2km below Küçükkonak, Zigana Pass, above Trabzon, mixed *Fagus* forest by stream, 5 Sept. 1970, *2270–2275* (BM, herb. CRFJ and herb. Reichstein). Gümüsane: c.10km below top of Zigana Pass, above Trabzon, clearing in *Picea* forest, 5 Sept. 1970, *2287a, 2287b, 2288* (BM and herb. CRFJ).

U.S.S.R.

Abkhazskaya A.S.S.R. Lashipse-Bzib valley, 25km above lake Ritsa, acid rock in coniferous/hardwood forest, 24 June 1971, *2818–2824* (BM & herb. CRFJ); 15km above Lake Ritsa, acid rock in mixed coniferous wood beside road, 28 June 1971, *2850* (herb. CRFJ); Bzib valley, 19km below Lake Ritsa, limestone in light conifer/hardwood forest beside road, 28 June 1971, *2854* (BM & herb. CRFJ); 20km below Lake Ritsa, limestone in thick, climax conifer/hardwood forest, ½km from road, 28 June 1971, *2867* (herb. CRFJ); 35km above turning into valley W of Ritsa valley, below Gora Agepsta, Gagrinskiy Khrebet, non-calcareous rocks in *Abies/Fagus* forest, C.1800m alt., 29 June 1971, *2889–2896* (BM, LE, E, herb. CRFJ and herb. Reichstein).

Rossiya S.F.S.R.: Kransnodarskiy Kray, between Chvezhipse and Krasnaya Polyana, N of Adler, Mzymta valley in *Fagus* forest, 27 June 1971, *2839* (herb. CRFJ); Karachayevo-Cherkesskaya A.O., in valley between Teberda river and Klukhurskiy Pereval, below Gora Dombáy-Ul'gen, Teberda valley, in coniferous/hardwood forest, c.2000m alt., 11 July 1971, *3201–3208* (BM and herb. CRFJ).

PLATE XXIII. Pinnae of *Dryopteris caucasica* (A–D) and *D. filix-mas* (E–G), all natural size and all coll. CRFJ. **A**: *2850*, Ritsa, Abkhazia. **B**: *2288*, Zigana Pass, Gümüşane, Turkey. **C**: *2287*, same loc. **D**: *2270*, same loc. **E**: *2200*, Ilgaz Dağ, Çankiri, Turkey. **F**: *1130*, Gerlos Pass, Tyrol, Austria. **G**: *989*, Mt. Harghitei, Mureş-Magyár, Roumania.

PLATE XXIII

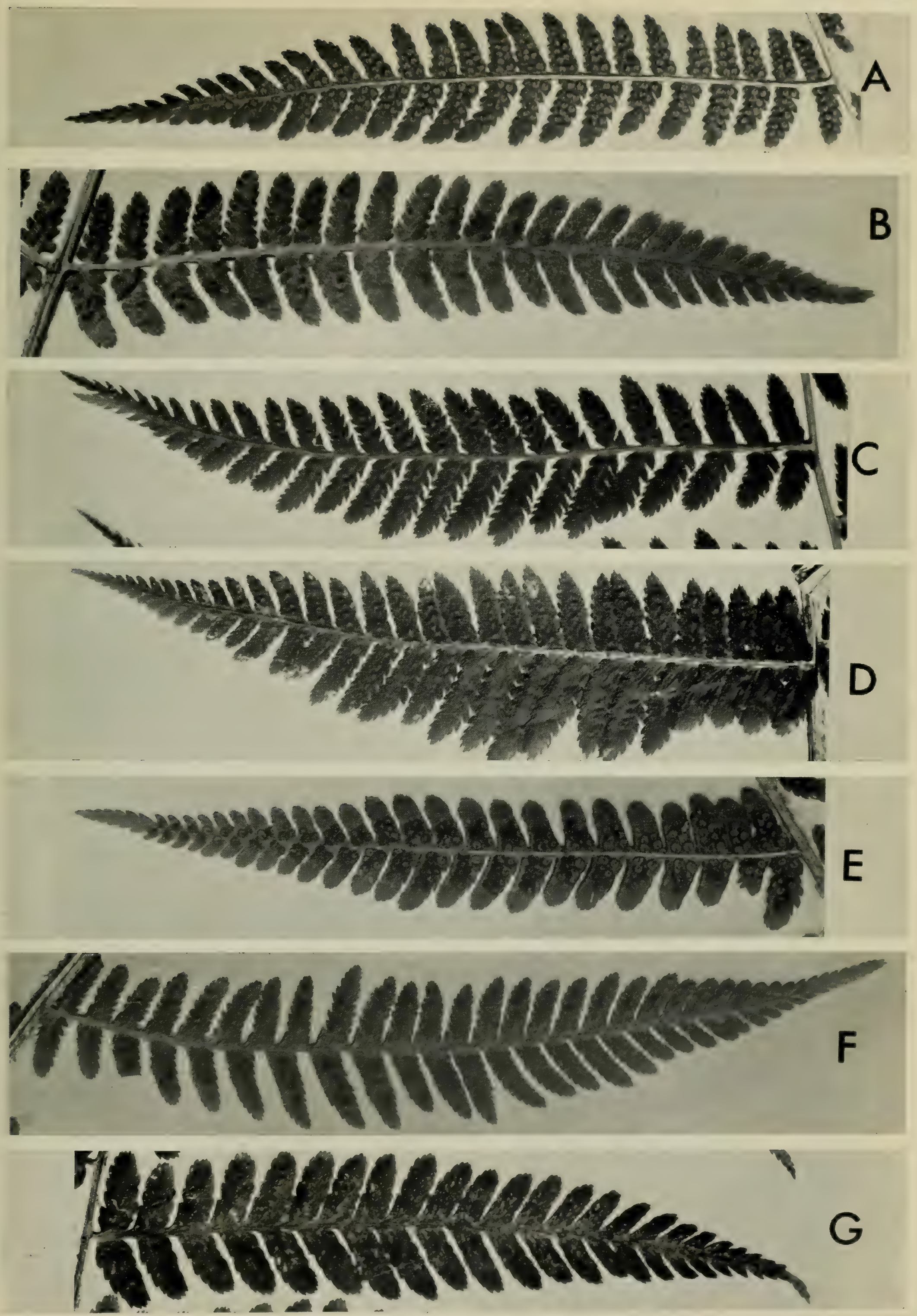
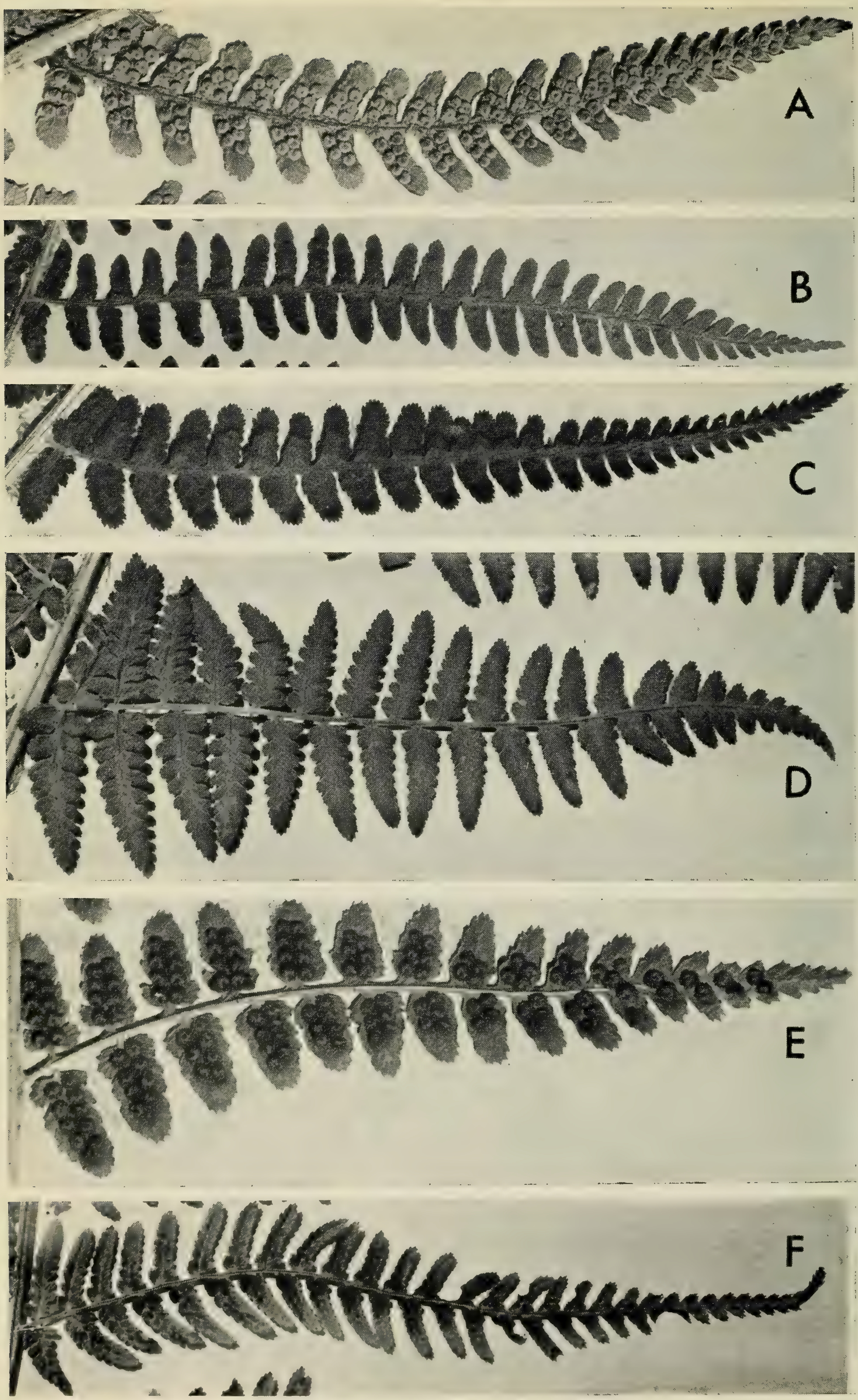


PLATE XXIV



Kabardino-Balkarskaya A.S.S.R.: 10km below Terskol (=Itkol) on Bukhaidze road below Gora Elbrus, Baksan valley, *Pinus* forest, c.2000m alt., 10 July 1971, *3076–3079* (BM, LE, G, E and herb. CRFJ).

Azerbaydzhan S.S.R.: in silvaticis ad montem schuscha ditionis Elizabethpol [Khanlar, Kirovabad], *Hohenacker,* Unio itiner., 1838 (BM); prov. Baku, distr. Kuba, prope Ozero Kuba, *Doluchanov & Tzaturov,* 27 June 1930 (BM); Transcaucasia, Karabach merid., prope Zamur in silvis 1750–1800m alt., *Karjagin & Minulin,* 3 July 1932 (BM).

IRAN

Gorgan: Mohammed Reza Shah reserve, 60–80km ENE of Gonbad-e-Qābūs, 6km S of Tangar, in light *Fraxinus* wood, in clefts at foot of N-facing limestone cliff, 1050m alt., 19 July 1971, *Edmondson 722* (LTR and herb. CRFJ).

In addition a very large number of other specimens, from throughout the Euxine region, were seen at the Botanical Institute Tbilisi (TBI).

CYTOLOGY AND HYBRIDS

Little cytological work has been carried out so far beyond chromosome counts to discover the level of ploidy. These were prepared from root tips in the standard way, using snail cytase, and being made from specimens collected wild and cultivated at the University of Leicester Botanic Garden. The following specimens were found to be diploid with $2n$=82:– CRFJ no.2082, CRFJ no.2409, CRFJ no.2272 and CRFJ no.2889 (see above for localities).

The remarkably small spore size of the other specimens not yet cytologically examined, being consistent with that of those mentioned above, points to their also being diploid.

Certain specimens intermediate in morphology between *Dryopteris caucasica* and other species in the *D. filix-mas* group were found to have abortive spores and, on morphological grounds, were assumed to be hybrids, and descriptions follow.

Dryopteris X **euxinensis** Fraser-Jenkins & Corley, **hybr. nov.** *[=D. caucasica* X *filix-mas]*

Hybrida, media inter parentes, infime pinnulae minores dissectae quam *D. caucasica*; sporae abortivae.

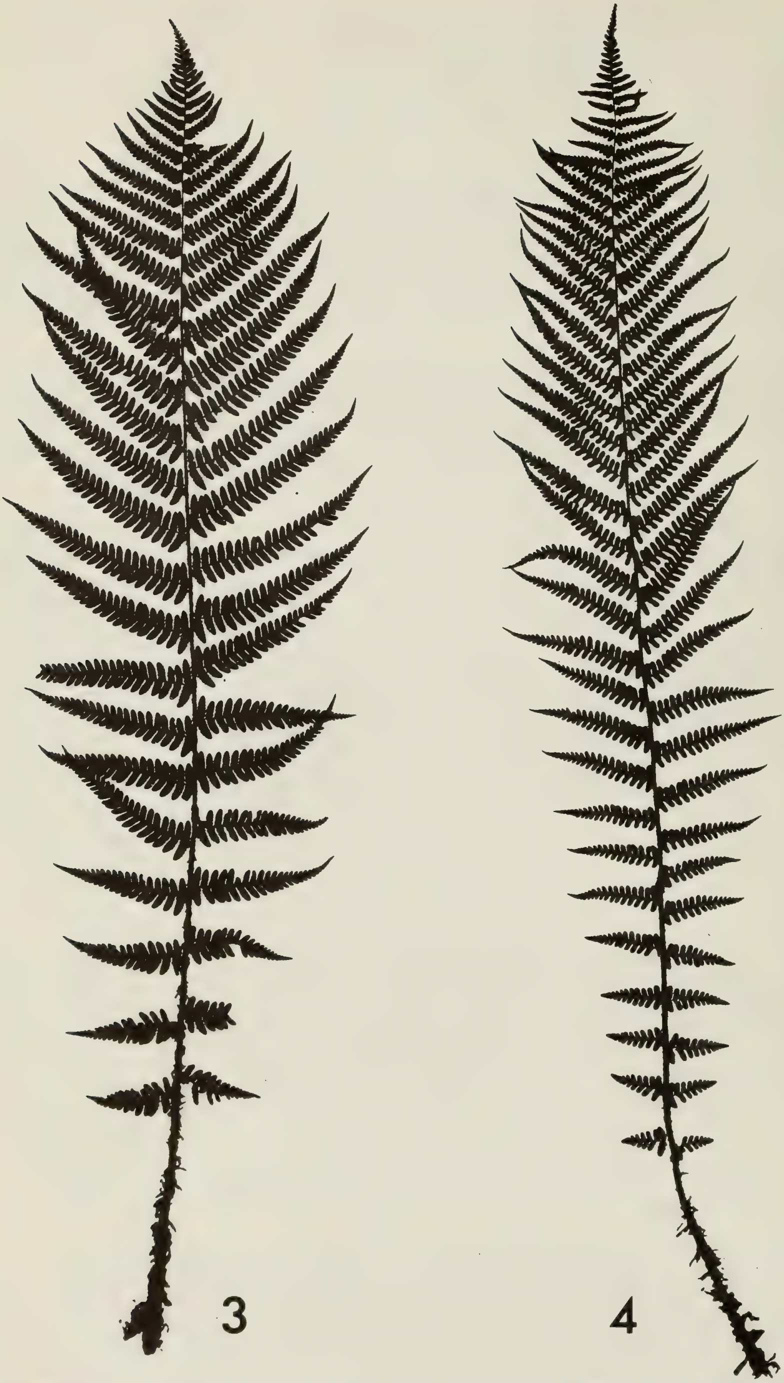
Holotypus: Turkey, Sinop, between Yenikonak and Gokceagac, south of Ayancik, in *Pinus/Fagus* forest beside road near top of pass on north side, 1 Sept. 1970, *C.R. Fraser-Jenkins 2234* (BM); **isotypi:** in LE, E and G.

Other specimens seen include the following:

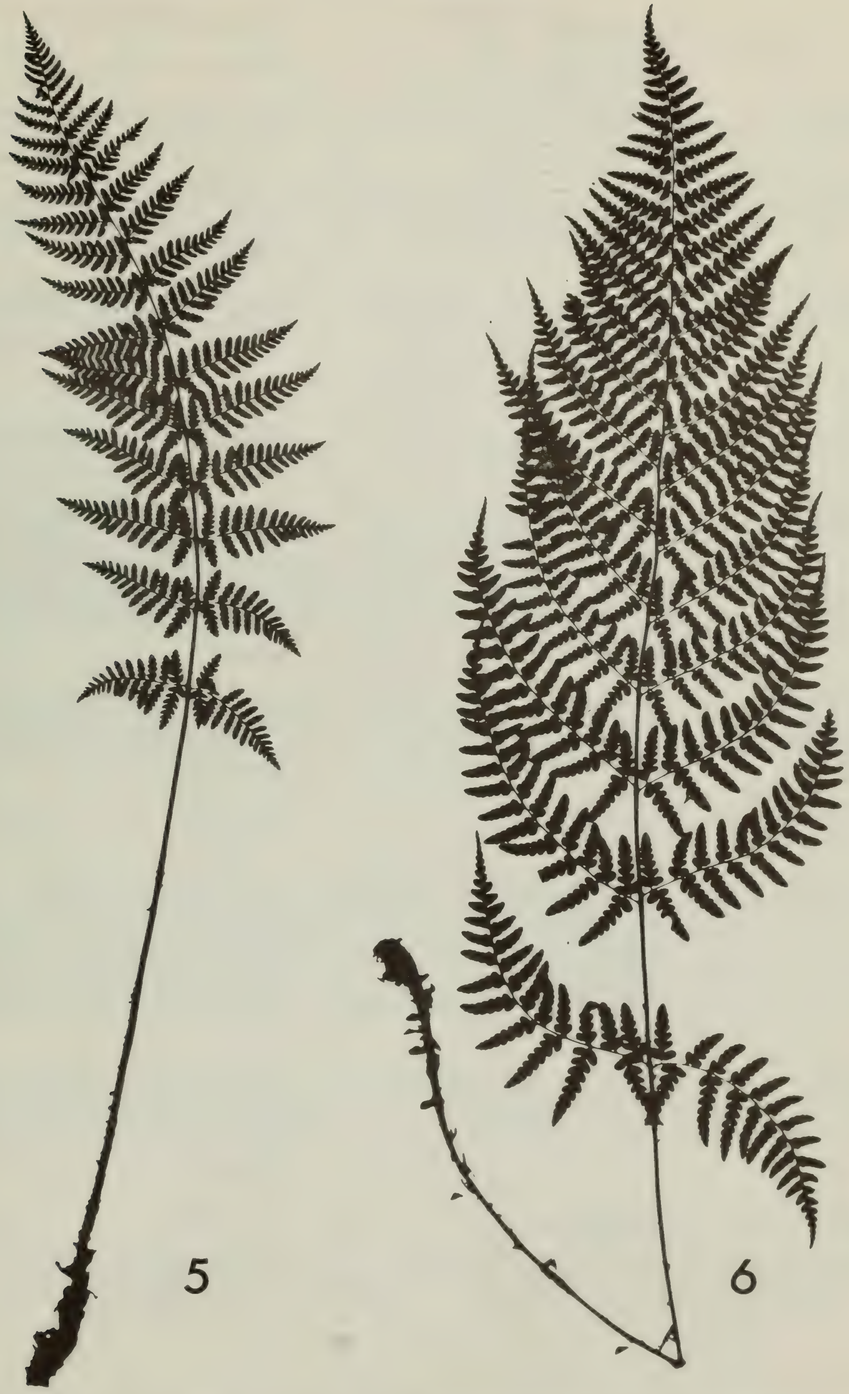
TURKEY Bolu: W side of Bolu Dagi, above Kaynasli, 18km west of Bolu, *Rhododendron* scrub, 900m alt., 18 Aug. 1970, *C.R.F-J. 2080** (BM).

U.S.S.R. Karachayevo-Cherkesskaya A.O.: Severniyy Priut, N side of Klukhurskiy Pereval below Gora Dombay-ul'gen, Teberda valley, *Pinus* forest, 2300m alt., 11 July 1971, *C.R.F-J.3209* (BM and herb. CRFJ).

PLATE XXIV. Pinnae of *Dryopteris abbreviata* (A–C) and *D. pallida* [2n] (D–F). **A**: *Tutin 4713,* Beattock, Dumfriesshire, U.K. X 2. **B**: *CRFJ 2847,* Ritsa, Abkhazia, U.S.S.R., X 1. **C**: *CRFJ 1895,* Col de Verde, Corsica, France, X 1½. **D**: *CRFJ 2123,* Akseki, Antalya, Turkey, X 1½. **E**: *CRFJ 2126,* same loc., X 2. **F**: *Reichstein 1544,* Astara, Rasht, Iran, X 1 (as *D. raddeana* Fomin).



FIGURES 3 & 4: Silhouettes of *Dryopteris* fronds. **3**: *D. filix-mas* X ¼; *CRFJ 3262,* Kiyev, Ukraine. **4**: *D. abbreviata* X ¼, *CRFJ 2897,* Ritsa, Abkhazia.



FIGURES 5 & 6: Silhouettes of *Dryopteris* fronds. 5: *D. villarii* (diploid) X ½, *CRFJ 1175,* Mt. Lessini, Vicenza, N Italy. 6: *D. pallida* X ½, *CRFJ 2126,* Akseki, Antalya, Turkey.

	D. CAUCASICA	**D. FILIX-MAS**
RHIZOME	Unbranched.	Little branched.
FRONDS	Eglandular, spreading, frost-sensitive.	Sometimes glandular, spreading, semi-persistent.
PETIOLE	1/2 length of frond, sparsely clothed with wide scales.	c.1/3 length of frond, ± densely clothed with wide and narrow scales.
LAMINA	Ovate-lanceolate, truncate at base, herbaceous in texture and usually paler green than any of the other three species.	Ovate-lanceolate, truncate at base, ± herbaceous.
PINNAE	Flat, ± horizontal, widest in middle.	Flat, ± horizontal, widest at base.
PINNULES	Apex acute, with very acute teeth; up to two lowest pairs of each pinna stipitate, basal pair often shorter than those above; basiscopic longer than acroscopic.	Apex acute, with ± acute teeth; basal pair of each pinna ± stipitate, usually longer than those above; basiscopic usually equally long as acroscopic.
ULTIMATE SEGMENTS	Truncate with several teeth, basal segments of basal pinnules not forming auricles.	Not truncate with few teeth, basal segments usually forming auricles.
STOMATA LENGTH	41–50μm	48–65μm
INDUSIA	1–2mm diam., flat, very thin and membranous, eglandular, white at all stages, considerably overlapping sporangia, shrinking at maturity; margins lacerate.	0.5–2mm diam., convex, thin, sometimes glandular, white when young, brown when old, slightly overlapping sporangia, shrinking at maturity; margins entire.
SPORES	31–37μm long, verrucate or shortly ridged.	37–45μm long, usually verrucate with small lobes and one or two wings especially at end of spore.
PLOIDY (x=41)	Diploid.	Tetraploid.
HABITAT	Forests in alpine regions.	Forests or open places on rocks lowland or alpine.

D. ABBREVIATA	D. PALLIDA/VILLARII
Much branched.	Much branched.
Often glandular, upright, frost-sensitive.	Very glandular, spreading or upright, frost-sensitive.
c.1/4 length of frond, densely clothed with wide and narrow scales.	1/2 length of frond, densely clothed with wide scales.
Lanceolate, tapering to base, ± coriaceous.	± triangular-lanceolate, truncate at base, ± coriaceous.
Usually concave, inclined to apex, widest at base.	Flat, inclined or horizontal, widest at base.
Apex obtuse or rounded with blunt teeth; basal pair sessile or slightly stipitate, longer than the pair above; basiscopic equally long as acroscopic.	Apex acute, with very acute teeth; lowest 2–3 pairs of each pinna stipitate, basal pair longer than the pair above; basiscopic equal to or slightly shorter than acroscopic.
Not truncate, with few or no teeth, basal ones forming auricles.	Not truncate, with several teeth, basal ones not forming pronounced auricles.
46–58μm	Variable depending on ploidy.
0.5–1mm diam., highly convex, thick, glandular, green when young, grey-brown when old, fitting closely round sporangia, scarcely shrinking; margins entire.	c.1mm diam., convex or rarely flat, thick, glandular, green when young, grey-brown when old, rarely completely covering sporangia, scarcely shrinking; margins entire or lacerate.
36–40μm long, verrucate or lobed to broadly and longitudinally winged.	Size variable depending on ploidy, irregularly and/or shallowly lobed.
Diploid.	Diploid and tetraploid.
Open screes and banks in alpine regions.	Open screes, banks and in forests in alpine and lowland regions.

Kabardino-Balkarskaya A.S.S.R.: 10m below Terskol (=Itkol) on Bukhaidze road below Gora Elbrus, Baksan valley, *Pinus* forest, 200m alt., 10 July 1971, *C.R.F-J. 3081, 3082, 3084* (BM and herb. CRFJ).

Dryopteris X **initialis** Fraser-Jenkins & Corley, **hybr. nov.** *[=D. abbreviata* X *caucasica]*

Hybrida media inter parentes sed dentes acuti, et pinnulae parvae dissectae; similis ad *D. filix-mas* ; sporae abortivae.

Holotypus: U.S.S.R., Karachyevo-Cherkesskaya A.O., in valley between Teberda river and Klukhurskiy Pereval, below Gora Dombay Ul'gen, Teberda valley amongst rocks above conifer/hardwood forest, c.2100m alt. 11 July 1971, *C.R. Fraser-Jenkins 3210* (BM); **isotypi:** in LE and G.

To complete the picture in the *D. filix-mas* group a third hybrid is here described, that between *D. filix-mas* and *D. abbreviata.* This is the triploid made artificially by Manton in her classic work quoted above. It has since been found wild (by H.V.C.) in three stations in Wales and one in the north of England, and by A.C. Jermy in the north of England. We have also found it growing in a garden in Oxford where the owners were unaware of what they were cultivating. The latter plant and the three from Wales have been cytologically checked by S. Walker of Liverpool University, who found they were triploids with approximately equal numbers of pairs and singles.

In all these plants the spores are abortive except for a few large, spherical spores which, however, must be chromosomally unbalanced as they appear to be sterile.

In appearance these hybrids somewhat resemble *D. filix-mas*, but features such as the pinnule teeth and the indusium tend to be intermediate between those of the parents. It is likely to be found wherever the parents grow together.

Dryopteris X **mantoniae** Fraser-Jenkins & Corley, **hybr. nov.** *[=D. abbreviata* X *filix-mas]*

Hybrida media inter parentes; similis ad *D. filix-mas*; pinnulae dentes et indusiae intermediae inter parentes; sporae abortivae; cytotypus triploideus.

Holotypus: on wall of slate quarry on Moelwyn Mawr, c.480m, Merioneth, vc.48; 12 Aug. 1962, *Corley 625* (BM); in cultivation at Faringdon.

Other specimens cytologically investigated: Caernarvon, vc.49, Lliwedd c.650m alt., 29 Sept. 1961, *Corley 623* (BM and in cult. at Faringdon); Tremadoc, c.100m, four plants forming small colony *Corley 619–622* (NMW, *619* in cult. at Faringdon), *624* (BM). Oxfordshire vc.23, in private garden at Oxford, *Corley 626* (BM).

It has been recorded by various authors from Europe and recently collected by C.R.F-J. in Spain [Léon prov., Puerto del Ponton between Cangas de Onis and Riano, 1100m, 14 July 1972, *3761* (BM); Soria prov., Puerto de Piqueras, Sierra Cebollera, north of Soria, 28 July 1972, *3809* (BM)].

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* Investigation of this plant showed there to be approx. 41 bivalents and 41 univalents at meiosis.

ACKNOWLEDGEMENTS

The authors wish to thank the Percy Sladen Memorial Trust of the Linnean Society and the Godman Trust of the British Museum (Natural History) for their financial assistance, enabling C.R.F-J. to mount a private botanical expedition to the Caucasus, and to thank the latter Trust for grants on two previous occasions.

Thanks are also due to Professor I. Manton, Dr J.D. Lovis and Dr A. Sleep, of Leeds University for their painstaking instruction and constant encouragement of C.R.F-J. in the techniques of counting chromosomes and breeding ferns. They also thank Dr G. Vida of Budapest, Professor T. Reichstein of Basel and Dr A.E. Bobrov of Leningrad for supplying much extremely useful information and material, and they wish especially to thank Mr A.O. Chater of Leicester University and Messrs A.C. Jermy and J.A. Crabbe of the British Museum (Natural History) for encouragement, advice and help with obtaining type specimens and essential information, and in the preparation of this paper.

H.V.C. wishes to thank Dr S. Walker of Liverpool University for a great deal of time and trouble in counting chromosomes and in giving much invaluable advice and encouragement.

Finally C.R.F-J. wishes to express a great deal of gratitude to Professor T.G. Tutin of Leicester University, who, as his supervisor, gave him the chance to implement a programme of doctoral research and ironed out every difficulty in his way.

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REVIEW

SYSTEMATICS OF THE NEOTROPICAL SPECIES OF THELYPTERIS SUBGENUS CYCLOSORUS by Alan R. Smith. University of California Publications in Botany 59:1–136, 1971. 170 X 258mm. Price $6.50. [U.C.P. 2–4 Brook St, London W1Y 1AA]

This is a detailed account of the species assembled by Christensen in *Dryopteris* subg. *Cyclosorus* in his monograph of *Dryopteris* (1913); Dr Smith transfers the subgenus to *Thelypteris*. His account is based on extensive field work in the south-eastern United States, Mexico and Costa Rica, on study of plants from many sources in cultivation by cytotaxonomic methods, and of more than 4000 herbarium specimens. In this process he has gathered together a great wealth of new knowledge on a group of closely related species which have hitherto been very imperfectly understood.

The total number of species dealt with is seventeen, and eight natural hybrids have been found. It is anomalous that *Aspidium gongylodes* Schkuhr, type of *Cyclosorus*, is not closely related to the other species which Christensen associated with it, and in fact Dr Smith's most important new information concerns these other species. They are found in more or less open or disturbed vegetation, not in primary forest. They are divisible into two sub-groups, one (3 spp) having known relationships in the Old World and including a single diploid the distribution of which extends to Malesia (*T.quadrangularis*; see Brit. Fern Gaz. 10:189–190), the other sub-group (11 spp) being centred on Mexico and including three tetraploids (probably all of hybrid origin) and five diploids (also three species not cytologically examined). The tetraploid *T.normalis* is intermediate between the two sub-groups. Some of the tetraploids are as aggressive in cultivation as in the wild; in the tropical fern-houses at Kew spores of *T.patens, T.normalis* and *T.dentata* often find their way into cultures of other species which they may suppress.

T.quadrangularis and its allies in the Old World belong to the genus *Christella* as recognized by me (Blumea 19:43; 1971). These Old World species appear to be centred on the region of N.E. India, Burma and W.China; they have not yet received a study at all comparable in detail with that accorded to the American species as dealt with by Dr Smith. As in America, the common species which colonize open places are tetraploid (*T.dentata* has spread very widely, following the destruction of natural vegetation by man, and is very variable; in recent years it has invaded the Americas and so appears in Dr Smith's treatment). There are in Africa a few species which appear to belong to Dr Smith's second sub-group, namely *T.gueintziana, T.callensii, T.chaseana* and *T.microbasis.* These have not yet been collectively distinguished from other free-veined Thelypteroid ferns in Africa, nor have they been studied by trained observers in the field. Only when they receive the same kind of study now accorded to the American species by Dr Smith shall we have a full understanding of the status of the sub-group, which I believe should also be included in the genus *Christella.*

Dr Smith's excellent study is a model which I hope will be followed by others. It indicates the subtle kinds of problems involved in dealing with a closely-allied group of species, and also the vast scope of the whole field of fern taxonomy. It further expresses the need for monographic work as a background against which studies of individual species can be judged.

R.E. HOLTTUM

POLYPODIUM AUSTRALE FÉE AND THE TETRAPLOID HYBRID IN SCOTLAND

A. RUTHERFORD* and A.McG. STIRLING**

Until recently the occurrence of *Polypodium australe* Fée in Scotland was not suspected despite the possibility that the reference in John SMITH's *Botany of Ayrshire*, 1896, to *'Polypodium vulgare* var. *serratum* Willd.' for Largs and West Kilbride and in the British Association Handbook 1901 (STEWART p. 109) to *'Polypodium vulgare* var. *semilacerum* Link.' for West Kilbride might refer to the diploid.

SYNNOTT (1970) drew attention to the occurrence of branched paraphyses among the sporangia of some herbarium specimens of *'Polypodium vulgare'* collected in Scotland in the latter half of the nineteenth century and these were subsequently determined as *P. australe* by R.H. Roberts. These early records have been considered by ROBERTS & SYNNOTT (1972).

During late 1971 and early 1972 efforts were made to determine the present status of *P. australe* in Scotland using the early records as a basis. Up to the time of writing the authors have knowledge of eleven localities for the diploid located in eight vice-counties.

Vice-county 72 Dumfries

MOORE (1859 p.67 t.III E) mentions a broad-fronded variety of the Common Polypody having been found at 'The Craigs, near Dumfries'. This record appeared to warrant further investigation and on 28th July 1972 a visit was made to Maidenbower Craigs near the town of Dumfries a locality which appeared to be the most promising in the area for Polypody species. *Polypodium australe* proved to be plentiful here, growing on rocks of Permian Sandstone breccia in company with *P. interjectum* and *P. vulgare*. This site differed in two significant respects from the previously examined Scottish sites. It was fairly heavily shaded by trees, this appearing to inhibit considerably the ability of the plants to produce sporing fronds; also there were no obvious indications that the rock was particularly basic.

Vice-county 73 Kirkcudbright

The earliest Scottish specimen of *P. australe* appears to have been collected by W.G. Johnstone in September 1850 as *'P. vulgare* var. *serratum'* from 'Colvend coast, Kirkcudbright', a somewhat ill-defined localisation. On 20 October 1971 *P. australe* was found growing abundantly near the mouth of the Southwick Burn at the base of cliffs of Silurian rock on the Solway shore (Grid. ref: 25/913560). It also grows as an epiphyte on elder and ash. At this site *P. interjectum* is exceedingly luxuriant in the shelter of trees, and with it was detected at least one colony of the rare 4*n* hybrid *P.* X *rothmaleri* Shivas. This is the first record for the tetraploid hybrid in Scotland and only the second for the British Isles. On 8 January 1972 a second Kirkcudbrightshire locality for the diploid was found on cliffs near Port Ling, some two miles west of the Southwick locality, also on Silurian strata. In contrast this site is in full exposure though south-facing like the other. Here also a colony of *P.* X *rothmaleri* grows with the putative parents close by.

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Vice-county 75 Ayr

A. Somerville in 1896 collected *'Polypodium vulgare* var. *acutum'* from 'woods, Portincross, Ayrshire'. On 17 September 1971 a small colony of *P. australe* was found with some *P.* X *mantoniae* Rothm. (the 5*n* hybrid) among a larger population of *P. interjectum* growing on conglomerate of the Old Red Sandstone, locally known as 'Pudding Rock', part of the raised beach cliff about a quarter of a mile north of Portencross Castle (Grid ref: 26/177495). On 3 January 1972 at Heads of Ayr (Grid ref: 26/287187) considerable outcrops of basic volcanic agglomerate were found to support extensive colonies of the diploid which grows at all elevations above six feet above high-tide mark but is most abundant towards the cliff top at about 200 feet (60m). The favoured habitats are exposed ledges and knolls, often partially concealed by grass and almost invisible from below. In sparse woodland, mainly ash, at the northern end of the cliffs in the shelter of the trees, fronds of *P. australe* frequently attained a length of 30 cm including the stipe, with the width across the broadest part of the frond up to 15 cm. At this locality the diploid grows epiphytically on ash and hawthorn. A further Ayrshire locality was discovered on 9 January 1972 at Lendalfoot (Grid. ref: 25/127895) where *P. australe* grows in very small quantity on ultrabasic rock. This site is on the coast six miles south-west of Girvan. Although suitable basic coastal rocks were searched from Kennedy's Pass, just south of Girvan, as far as Bennane Head, north of Ballantrae, a distance of about six miles, no other colonies of the diploid were found.

Vice-county 83 Midlothian

A sheet in the herbarium of the Royal Botanic Garden, Edinburgh bears two small fronds of *'P. vulgare'* collected on Arthur's Seat, Edinburgh by J. McNab in 1855. These superficially suggest the diploid, having narrow, distinctly serrate pinnae, but are not otherwise determinable with certainty. A far from thorough search of the south-facing rocks of Arthur's Seat on 7 April 1972 failed to reveal any *P. australe*. Soon after this it came to the notice of the authors that B. Simpson of Seamill, Ayrshire had, in a collection of ferns made in the Edinburgh area, a frond of *'P. vulgare'* from 'south-facing rocks, Arthur's Seat' collected between July 1957 and December 1958. This frond is broadly ovate in outline and has narrow, strongly serrate pinnae. Sori were present and were sufficiently mature for microscopic examination to reveal the presence of branched paraphyses among the sporangia thus confirming the occurrence of the diploid in this locality. This represents the earliest recent record for *P. australe* in Scotland as well as being one of the few records for the east side of the country. The habitat at Arthur's Seat is steep basalt rocks with a strong basic character. The plant was again seen in this locality by one of the authors on 23 May 1972. It appears to be confined to one comparatively limited area of rock.

Vice-county 89 East Perth

We have seen a specimen of *P. australe* from this vice-county collected by Mrs. J. Castle-Smith in a locality which we are not at liberty to disclose. This plant was collected in 1969.

Vice-county 98 Argyll

On 5th September 1972 three colonies of *P. australe* were found in close proximity on south-east facing limestone rocks of the raised beach cliff just to the south-west of Achnacroish on the island of Lismore (Grid ref: 17/846401). This record is of considerable interest, representing not only the first recorded occurrence of the diploid on limestone in Scotland, but also the most northern site yet located in the British Isles and, indeed, in Europe.

Vice-county 100 Clyde Isles

The south coast of the Isle of Arran appeared to be a likely locus to search for *P. australe* and during visits on 2nd and 13th June 1972 a few colonies were found on cliffs in the vicinity of Bennan Head (Grid ref: 16/99-20-). Due to the rough nature of the ground in this area it was not possible to examine more than a short stretch of cliff in the time available. Further search may well show the diploid to be more widely distributed on the island.

Vice-county 102 South Ebudes

On 4th June 1972 during a visit to Islay a colony of *P. australe* was discovered growing on a quartzite rock outcrop in a sand dune area at Kilinallan in the north of the island (Grid ref; 16/313722). Quartzite is normally a very poor rock type as regards the quality of the flora which it supports. In this instance however there was enrichment of the soil in the rock crevices by blown sand from the dune area. A similar example in Wales is mentioned by HUGHES (1969). Although considerable exposures of limestone occur on Islay *P. australe* was not detected on this formation.

Other records

The old records for vice-county 77 Lanark, and vice-county 85 Fife (SYNNOTT 1970; ROBERTS & SYNNOTT 1972) still lack recent confirmation, search in the original localities having so far proved negative.

Continued search will undoubtedly lead to the discovery of additional sites for *P. australe* in Scotland and it is likely to prove widespread though extremely local south of the Central Highlands.

ACKNOWLEDGEMENTS

Our thanks are due to Mr R.H. Roberts for determinations of *Polypodium* material and for help in other ways and to the Regius Keeper, Royal Botanic Gardens, Edinburgh, and Mr D.M. Synnott, National Botanic Garden, Glasnevin, Dublin, for the loan of herbarium specimens.

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REVIEW

A COMPUTOR-MAPPED FLORA by D.A. Cadbury, J.G. Hawkes and R.C. Readett; v + 768 pp., 12 overlays and geological map in black pocket; 225 x 290mm. Academic Press, London and New York, 31 Dec. 1971. Price £10 ($30.00)

This is a vascular plant and bryophyte flora of v.-c.38, Warwickshire with all the usual subsidiary chapters on soils, geology, climate, history and land-use by distinguished scholars in their fields. Notes on the vascular plants present (including 41 pteridophytes) are given in 110 pp. The bulk of the work consists of 979 maps (21 ferns and 183 bryophytes). The base-maps are printed in blue and the symbols have been printed by an incremental plotter with a drawing pen controlled by a punched tape produced by a computor (at Birmingham University). Maps of the bryophytes and a number of vascular plants (including *Polypodium vulgare* s.s. and *P. interjectum* and *Cystopteris fragilis*) have been produced by the more conventional line printer. A feature of the mapping has been that records have been made and plotted on a basis of nine major habitats. Early in the project a 1-km sq in each tetrad was randomly chosen and recorders were asked to concentrate on these thus eliminating recorders' bias for the more interesting habitats. Nine symbols (at two line thicknesses to indicate frequency of species) may be plotted in each 1-km square and maps look confusing until one has learnt to read the symbols. The overlays are of course useful, but I wished they had narrower borders to allow easy marrying by using the spine of the book as a guide; as it is it must spread across to the other page.

As far as the pteridophytes are concerned there is ample data for thought. *Pteridium* is recorded for the heavy calcareous soils on S and SE but 41 of the records are from hedgerows and scrub. Another interesting habitat record is in *Equisetum telmateia* where 44 records are from watersides and marshes. A glance at the map will tell that most of the other records are from hedgerows, waste places and roadsides and that only in 8 squares are other habitats encountered (woodland 6, and grassland and cultivated one each). It is interesting to note how many ferns turn up on waste places although this may be due to recorders not correctly noting habitats. The distribution of ferns is governed by soil rather than climate it appears.

One very good aspect of the Flora is the notes (and occasional keys and figures) given on characters found useful when identifying that species in Warwicks. Thus it is rightly noted that in *Polypodium*, frond shape and sori (shape?) are not satisfactory characters to distinguish segregates and that the annulus number should be checked. One could add colour of annulus in relation to sporagium wall, and shape of rhizome scale.

This book is the result of a well thought out project and at £10 may not be on everyone's bookshelf. But every field botanist should read it and browse the maps and I am sure many will be tempted to buy it.

A.C. JERMY

MEIOSIS IN APOGAMOUSLY PRODUCED DIPLOID PLANTS OF ASPLENIUM SEPTENTRIONALE

J. BOUHARMONT*

ABSTRACT

Diploid sporophytes of *Asplenium septentrionale* have been obtained by cultivation of gametophytes from the normal tetraploid cytotype. These sporophytes were sterile and their meiosis was very irregular: at metaphase I, only 37% of the chromosomes were paired. The higher prophase pairing confirmed the autoploid nature of the original tetraploid, but the homology of its genomes is relatively low comparatively to the tetraploid *A. ruta-muraria* and *A. trichomanes.*

INTRODUCTION

One of the best ways to elucidate the origin of a plant species is the observation of chromosome pairing in occasional haploid individuals. Induction of haploidy by apogamous development of sporophytes has been reported in several pteridophytes and meiosis observations have been used in two *Dryopteris* (MANTON & WALKER 1954) and *Asplenium trichomanes* L. (BOUHARMONT 1972a).

The present paper reports some observations performed on *Asplenium septentrionale.* That species is a tetraploid, with 144 somatic chromosomes, but a diploid cytotype is known from the Caucasus (LOVIS & REICHSTEIN 1964). In 1952, MEYER reported the development of numerous apogamous sporophytes on *A.septentrionale* prothalli cultivated on dry soil or agar, but in humid atmosphere.

MATERIAL AND METHODS

The original plants of *A.septentrionale* (L.) Hoffm. were collected on schistose rocks in the Lesse valley, at Ciergnon (Belgium). Apogamous development was achieved by sowing the spores and culturing the prothalli on a synthetic medium according to the techniques previously described (BOUHARMONT 1972a). The base medium was Knudson's solution with the micronutrients of Heller and 0.8% agar. Positive results have been obtained with different concentrations of sucrose or glucose and different growth substances. The first sporophytes appeared nine months after sowing and the transfer of prothallus fragments onto fresh medium still gives apogamous plantlets after four years. Several hundreds of sporophytes have been raised from the same culture.

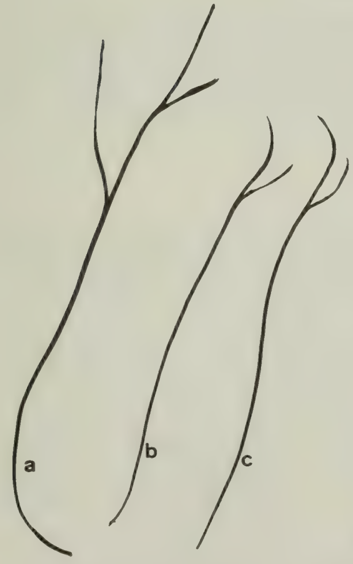

FIGURE 1: Silhouettes of fertile fronds of *Asplenium septentrionale;* **a**: from a normal tetraploid plant; **b** & **c**: from diploid plants induced by apogamy (natural size).

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When the sporophytes had 2–3 leaves they were placed on silliceous substrate and covered to maintain humidity. The apogamous sporelings did not possess roots but they produced adventitious ones after several months on the soil. Their growth was very slow and the first sporangia appeared two years after planting. Adult diploid plants remained smaller than their tetraploid counterparts, their leaves were shorter and less divided (Fig.1) and the size of their stomata was reduced. The fronds generally bore few sporangia.

The meiosis of the diploid *Asplenium septentrionale* was studied after staining by aceto-carmine, using the classical squash method.

CYTOLOGICAL OBSERVATIONS

The observations made during the first meiotic division showed the diploid number of 72 chromosomes and a very variable pairing from cell to cell. Counting was easier at the end of diakinesis or metaphase. For 21 cells observed at these stages, the number of univalents varied from 30 to 62 (Plate XXV; Fig.2); the mean numbers of chromosome associations were 13.1 bivalents and 45.7 univalents. In early diakinesis it was much more difficult to count the chromosomes *exactly* and to make a distinction between uni- and bivalents. Nevertheless the univalents were clearly fewer and thus pairing more complete in prophase than in metaphase. (Plate XXV; Fig.2a) shows a cell with probably 8 unpaired chromosomes.

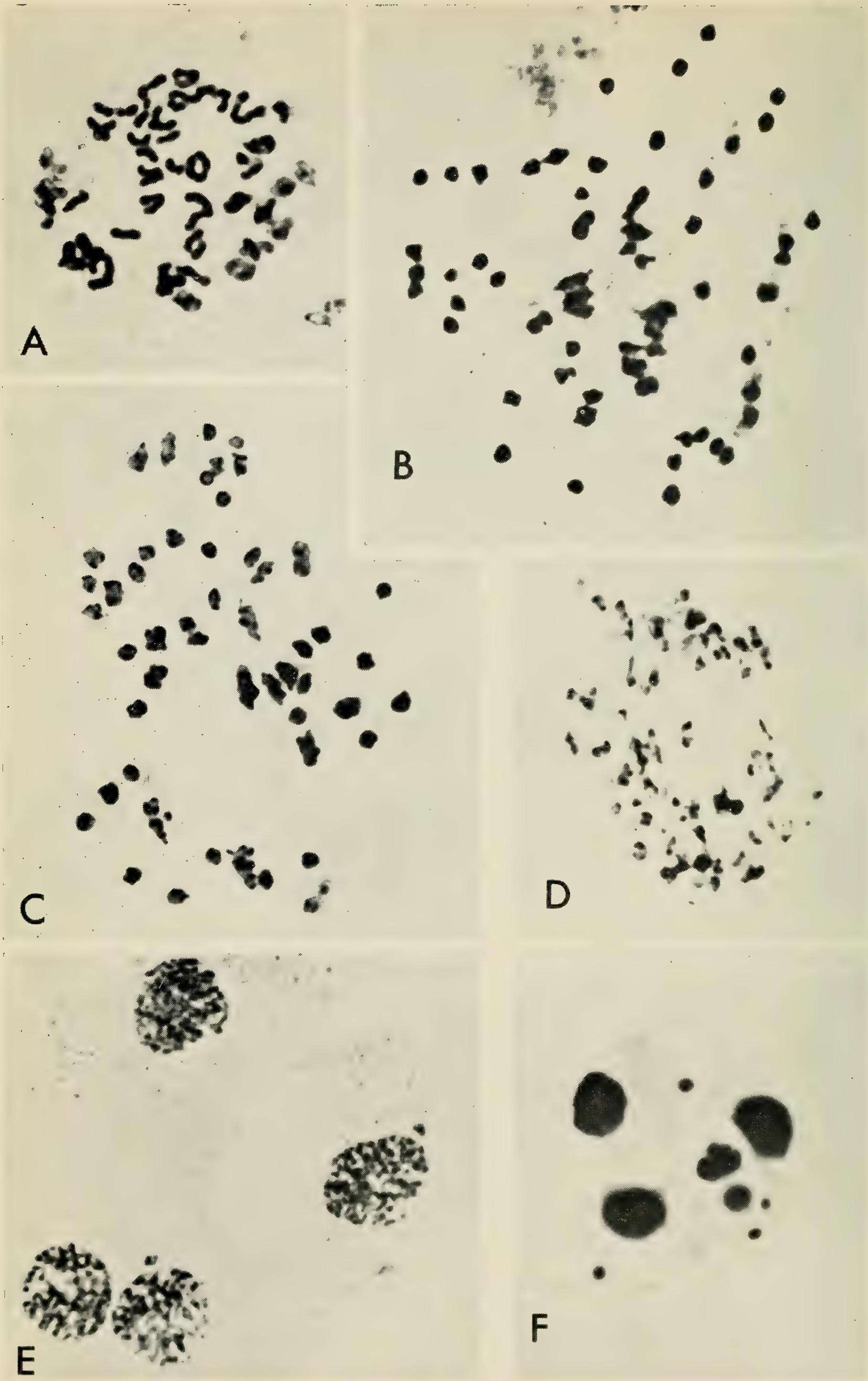
Anaphase I was always very irregular, the segregation of chromosomes and their migration towards the poles were not synchronous (Plate XXVD). The majority of them were however included in the telophase nuclei and very few were lagging. In spite of an irregular second anaphase, the four nuclei of the tetrad were generally regular and of similar size but there were also a few micronuclei and some "tetrads" were very abnormal (Plate XXVE,F).

Immature sporangia contained aborted and shrivelled spores, but the proportion of cells of regular shape was important. However in mature sporangia, the spores were entirely sterile or nearly so. The late spore abortion and sterility were probably due to a random distribution of the chromosomes during anaphase and to the production of unbalanced nuclei.

DISCUSSION

The comparison of these results with the observations previously made in induced diploid plants of *Asplenium trichomanes* (BOUHARMONT 1972a) showed some similarities and differences between these two species. Both induced diploid forms showed a relatively high chromosome pairing at diakinesis and a subsequent desynapsis, but the mean number of univalents at metaphase was higher in *A.septentrionale* (45.7) than in *A.trichomanes* (11.8). The migration of the chromosomes at anaphase I and II was also more irregular and the spore sterility higher in *A.septentrionale.* The spore tetrads were nevertheless relatively regular. The large number of univalents in metaphase probably indicates a lack of chiasmata between some paired prophase chromosomes but it is also a consequence of the delayed anaphase and of the precocious segregation of some bivalents, frequently found in species hybrids. The relatively regular shape of tetrads and young spores is due to a mechanical expulsion of the univalents from the spindle to the poles; the result of such a random distribution of the chromosomes is the complete failure of the spores at maturity.

PLATE XXV



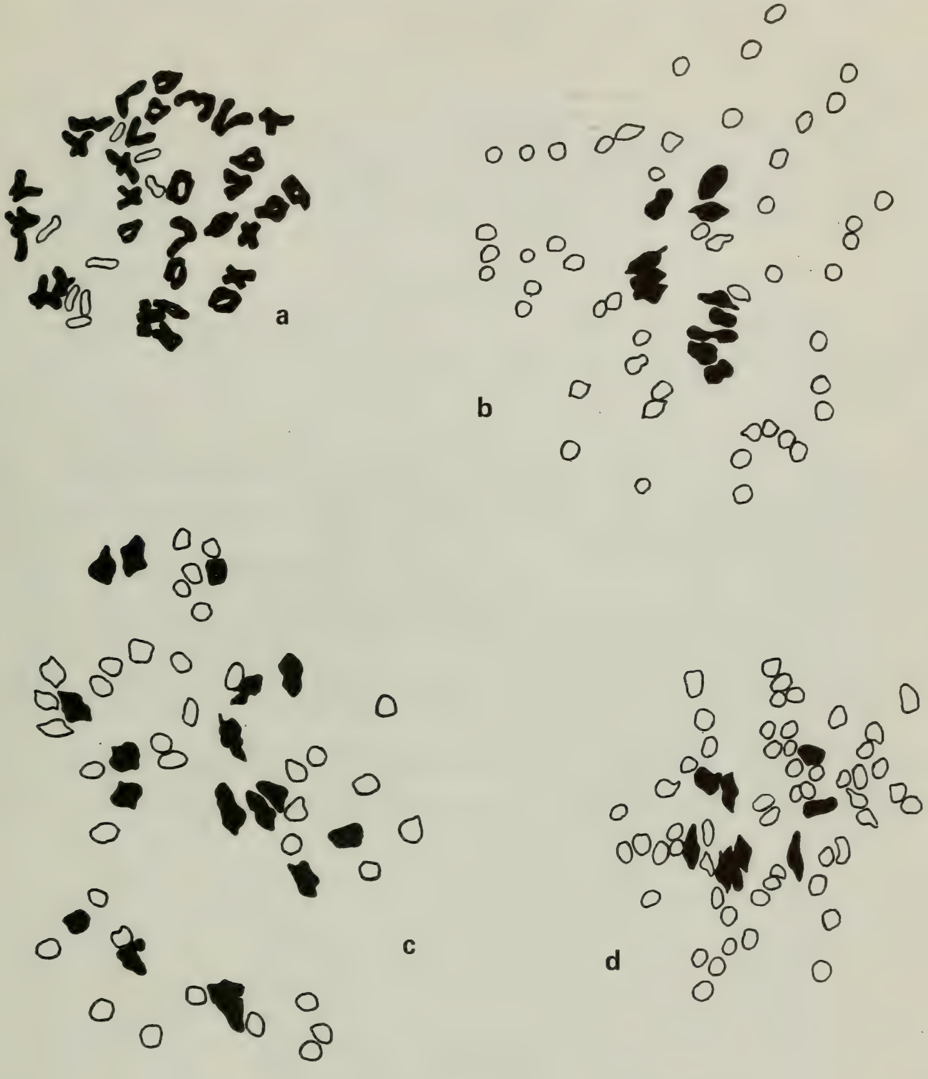


FIGURE 2: Camera lucida drawings showing chromosome pairing in induced diploid plants of *A. septentrionale* X 1500). **a**: diakinesis with probably 8 univalents; **b**: late prophase or metaphase with 11 bivalents and 50 univalents; **c**: 18 bivalents and 36 univalents; **d**: 9 bivalents and 54 univalents.

PLATE XXV. Meiosis in induced diploid *A. septentrionale* X 1500. **A**: diakinesis (Fig.1a); **B;C**: late prophase or metaphase (Figs.2b,c); **D**: very irregular first anaphase; **E**: spore tetrad with two visible micronuclei; **F**: very abnormal "tetrad".

The nature of polyploidy in *A.septentrionale* has been studied after interspecific crossing. *A.* X *murbeckii,* a tetraploid hybrid between *A.septentrionale* and *A.ruta-muraria* L. showed 60–62 bivalents ascribed to autosyndesis and indicating the autopolyploid origin of both parents (LOVIS 1963, 1964; LOVIS and REICHSTEIN 1964). Other observations showed the high degree of homology between the genomes of *A.ruta-muraria* (VIDA 1970; BOUHARMONT 1972b). Thus it is probable that a high proportion of the bivalents found in *A.* X *murbeckii* involved chromosomes of *A.ruta-muraria* and that the contribution of the *septentrionale* chromosomes was lower. Our observations did not disagree with the hypothesis of an autoploid origin for *A.septentrionale*, but they indicated that the homology between the genomes is relatively low in comparison with tetraploid *A.ruta-muraria* and *A.trichomanes.* It is possible to explain the origin of the present tetraploid form of *A.septentrionale* by a hybridization between two relatively evolved diploid types; another possibility is a chromosome doubling in a single diploid form at a time sufficiently old to allow a progressive differentiation in the genome.

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THE ANATOMY OF MAXONIA APIIFOLIA: A CLIMBING FERN

T.G. WALKER*

ABSTRACT

Maxonia apiifolia (Sw.) C. Chr. is an example of an epiphytic fern which starts its life rooted as a normal terrestrial species eventually to become scandent. The fronds produced differ in their morphology and anatomy depending from which part of the rhizome they originate. These differences are described and the significance and mechanisms producing the effect are briefly discussed.

INTRODUCTION

In temperate countries the ferns are almost exclusively terrestrial in habit, thus contrasting with the situation in the tropics where a relatively high proportion of species and even genera are epiphytic. Both the terrestrial and the epiphytic habitats have their own characteristic features and peculiarities which differ markedly from each other even in the same area. Thus, a terrestrial fern living near the base of a tree in a forest may well be inhabiting a very uniform environment in which the light intensity is very low, the soil is constantly moist, the atmosphere still and humid and in which there is little change in temperature. A fern growing epiphytically near the top of the same tree would be in a very different environment, in which, for example, water is available during actual rainfall and for only a short time afterwards due to the rapid run-off from the surface of the tree. In addition, the exposed position of the plant will be subjected to far greater fluctuations of temperature, humidity and air movement than in the shelter of the forest and the light intensity will be increased many times over.

Different ferns react to these different habitats in a wide variety of ways but it is nevertheless true that the physiology, anatomy and morphology of species which are more or less related reflect the environment in which they grow and frequently terrestrial and epiphytic forms differ markedly from one another.

There is a small group of ferns in both the Old and the New World tropics which in a sense bridges the gap between the terrestrial and epiphytic habits — ferns such as *Stenochlaena, Teratophyllum, Lomariopsis, Polybotrya*, etc. These ferns are all scandent and start life rooted in the forest floor. The rhizome grows horizontally, often for a considerable distance until it makes contact with the base of a tree. The direction of growth then switches from horizontal to vertical and the rhizome climbs the tree. As the plant thus moves from one environment to another it encounters very different conditions and various modifications in morphology, anatomy and physiology take place — some of which are very striking. Whilst there are detailed accounts in the literature of certain aspects of some of these ferns, e.g. the heterophylly of *Teratophyllum* and other genera (see HOLTTUM 1954a & 1954b), few members have been examined in detail despite some remarkably interesting morphogenetic and physiological problems which would well repay closer study.

During the course of several visits to Jamaica I had the opportunity to collect and study in the field one such scandent fern, namely *Maxonia apiifolia* (Sw.) C. Chr. *Maxonia* has a very limited geographical range and consists of the single species of

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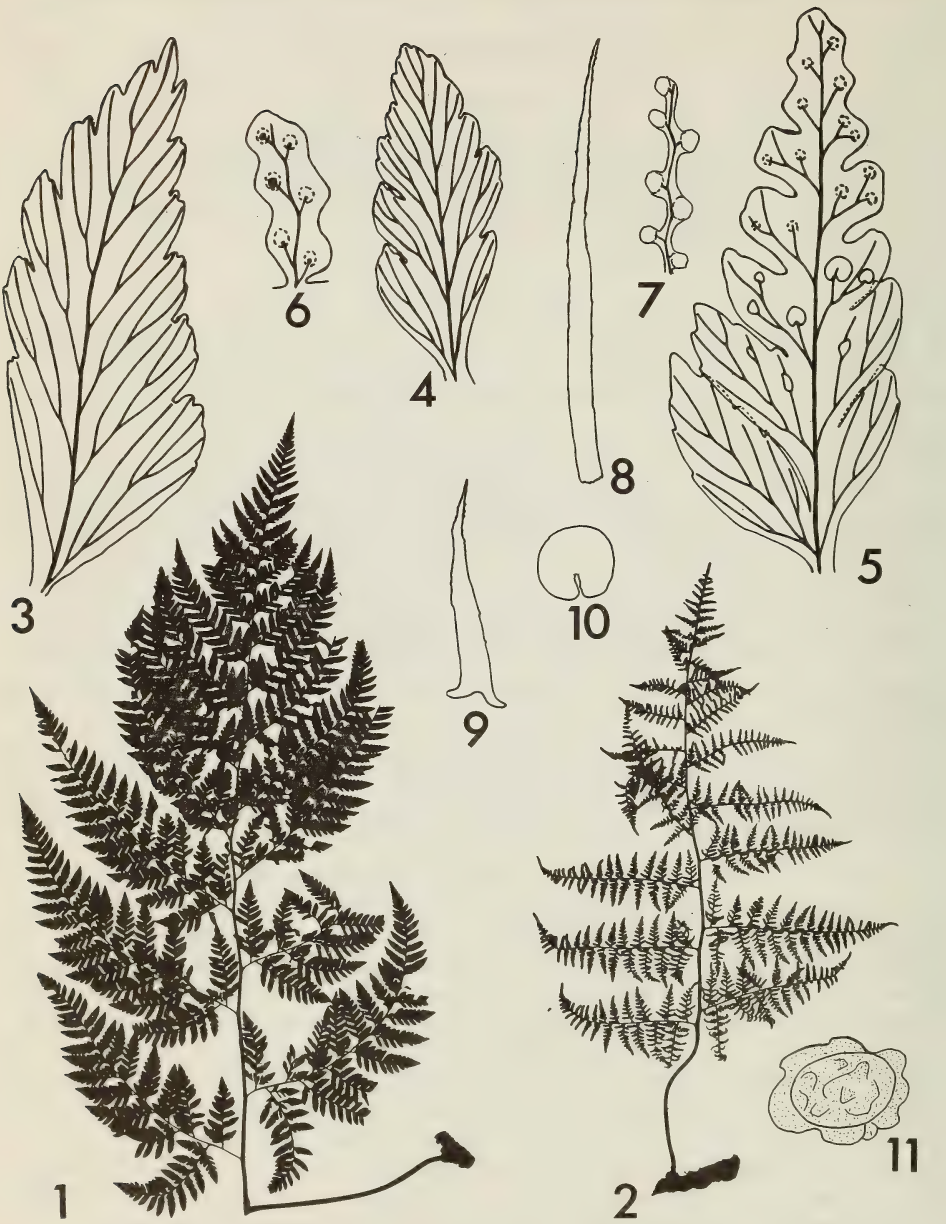

FIGURES 1—11. Morphology of *Maxonia*. **1**: silhouette of sterile scandent frond, X $\frac{1}{8}$. **2**: silhouette of fertile scandent frond, X $\frac{1}{8}$. **3**: sterile scandent segment, X 3.2. **4**: sterile terrestrial segment, X 3.2. **5**: abnormal segment of scandent frond, X 3.2. **6**: pickled fertile scandent segment, X 3.2. **7**: dried fertile scandent segment, X 3.2. **8**: scale of scandent rhizome, X 4. **9**: scale of terrestrial rhizome, X 4. **10**: mature indusium, X 6.5. **11**: spore, X c.350.

which the typical form occurs in Cuba and Jamaica whilst the variety *dualis* is restricted to Guatemala.

It is found in a number of localities in Jamaica and my own material was collected at c.2750 feet (825m) above sea level near the road to Hollymount, Mount Diabolo in the parish of St. Ann where it is relatively abundant. Here it is not entirely restricted to the forest but also grows in small open grassy areas from which the forest has been removed.

MORPHOLOGY AND ANATOMY

Because the morphology, anatomy and general behaviour of this fern differs according to whether it is rooted in the ground or climbing a tree it has usually been found necessary in the following account to give two descriptions of the same organ.

The rhizome

The terrestrial* rhizome creeps just under the soil surface – often for long distances – and is more or less smooth in outline, i.e. it lacks the longly decurrent stipe bases which are present in the scandent rhizome giving the latter an irregular appearance. Scales are borne which measure approximately 8 mm X 1 mm and are concolorous with irregularly toothed margins (Fig.9). These scales are somewhat sparsely scattered along the rhizome except at the growing point where they are abundant and protect the delicate apex. The rhizome is oval in transverse section (Fig.13) and measures some 6 mm across at the widest point. The vascular system is a dictyostele and at any one level there may be seen the smaller traces of at least two fronds. In the cortex there are a few scattered groups of cells bearing thick opaque deposits of brown/black phlobaphene on their walls. A layer of lignified cells surrounds the rhizome immediately beneath the epidermis.

The rhizome changes its character suddenly and markedly on altering its direction of growth from the horizontal to the vertical and scandent. It becomes flatter and moulds itself more closely to the contours of the substrate and the roots penetrate the crevices in the bark with the result that the fern adheres very firmly to the tree and can only be detached with some difficulty. Very conspicuous golden scales are present which are similar in morphology to those of the terrestrial rhizome but are very much larger, viz. 16 mm X 1.5 mm (Fig.8). They invest the whole of the scandent rhizome in a thick covering, contrasting with the situation in the terrestrial rhizome where the scales are concentrated at the growing point and are sparse elsewhere.

The diameter of the rhizome increases some three and a half times from 6 to 21 mm and the outline in cross section from an oval to a more irregular shape in which three bulges are usually present (Fig.12). These bulges are caused by the decurrent stipe bases retaining their identity for some distance even though they are fused to the rhizome. There are normally three groups of frond traces (corresponding with the three bulges) to be seen at any one level and there are many more groups of phlobaphene-containing cells than in the terrestrial rhizome. The outer cortical layer tends to be more heavily lignified than the corresponding layer in the terrestrial portion and imparts a tougher, more woody character to the rhizome.

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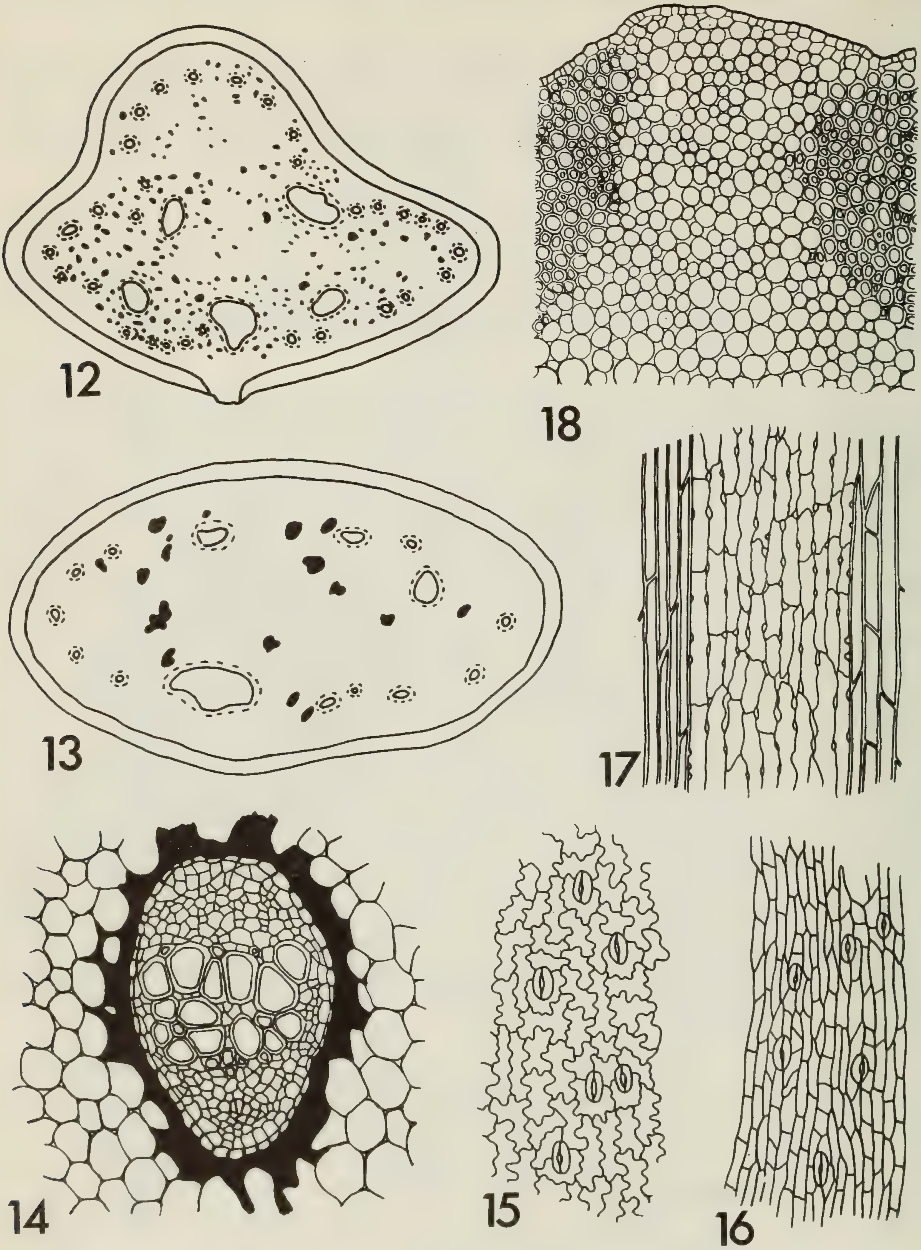
*The word terrestrial is used here for any part which has originated on a ground-growing plant, e.g. a terrestrial frond has grown from a soil-rooted rhizome. Similarly, the word scandent is used for climbing parts.



FIGURES 12–18. Anatomy of *Maxonia*. **12**: T.S. scandent rhizome, X 3. **13**: T.S. terrestrial rhizome, X 12. **14**: T.S. stipe vascular strand, X 135. **15**: lower epidermis of sterile scandent frond, X 100. **16**: epidermis of pneumathode, X 100. **17**: L.S. pneumathode, X 100. **18**: T.S. pneumathode, X 92.

The fronds

The fronds are produced singly at intervals along the rhizome and are quadripinnate. Those produced on the terrestrial rhizome are entirely sterile and although very similar in appearance to the sterile scandent fronds are smaller, both in overall size and in the size of the individual segments (compare Figs.3 and 4). Internally, there are other differences.

The scandent rhizome produces sterile fronds abundantly (Fig.1) and also fertile ones. The latter are produced very sporadically and several visits to the same locality were necessary before specimens were found at a suitable stage for cytological fixation (WALKER 1966).

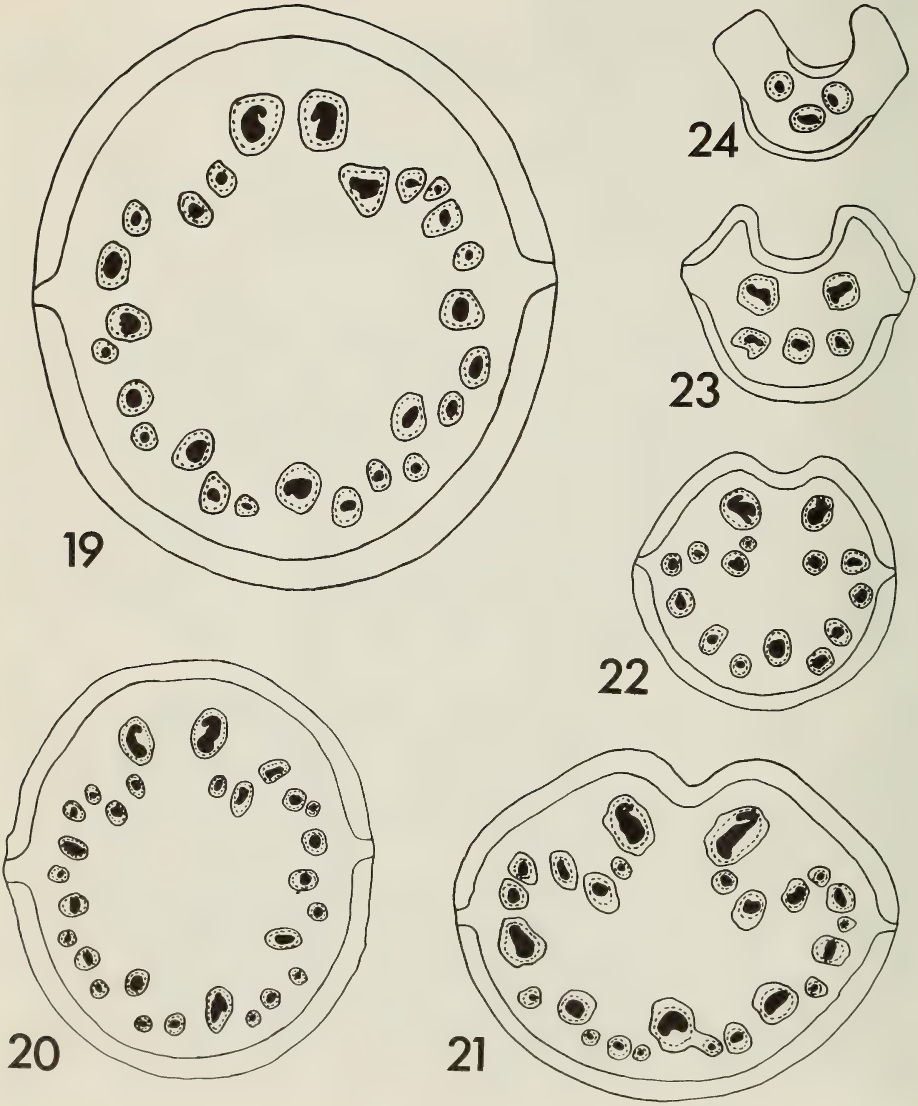
The fertile fronds differ markedly in appearance from the sterile ones but basically they are constructed in the same way – the striking difference being produced by the great reduction in the laminar surface of the fertile segments (Fig.2). A fertile segment which was fixed in the field in formalinacetic-alcohol is illustrated in Fig.6. It can be seen that the area of the lamina is less than one fifth of that of a comparable sterile segment (Fig.3) and that the venation has been both reduced and simplified. Instead of there being seven or eight pairs of veins which are themselves once or twice branched as in a sterile segment there is only a single vein bearing short arms which terminate beneath sori. The reduction in laminar surface is further accentuated in herbarium specimens where the soft tissues between the veins shrink to a greater degree than the other tissues thus producing the effect shown in Fig.7.

Very occasionally one, or at most a very small number, of segments or pinnules may become fertile on what is morphologically a typical sterile scandent frond. One such case is illustrated in Fig.5 and rather closely fits the description of forms given by CHRISTENSEN (1916) in which he points out that in the earlier stages the indusium is elongate and very similar to that found in *Cystopteris* or *Davallia* before it broadens out to assume its final mature shape (Fig.10).

The sori lack paraphyses and the sporangia are long-stalked and non-glandular, with 18 to 23 indurated cells in the annulus. The spores are bilateral, light brown in colour and the surface is thrown up into folds. There is a wavy wing to the perispore, the whole being densely covered with small fine spinules (Fig.11). Cytological examination (WALKER 1966) has shown there to be 41 pairs of chromosomes at meiosis, which is in agreement with the placing of *Maxonia* in the Aspidiaceae on morphological grounds.

Internally, all three types of fronds (terrestrial sterile, scandent sterile and scandent fertile) have much in common and, somewhat surprisingly, where they do differ the distinction is not between the sterile fronds on the one hand and the morphologically very different fertile frond on the other, but between terrestrial and scandent sterile fronds. Indeed, the scandent sterile and fertile fronds are so alike in the construction of the stipe, rhachis etc., that the illustrations are completely interchangeable and only a single series (Figs.19–24) has been presented for this reason.

In all cases the stipe and rhachis have a broad band of sclerenchyma immediately below the epidermis and the cells lack intercellular spaces. Thus, not only is this layer mechanically strong but it would also effectively impede gaseous exchange between the interior and the environment if it were complete. However, the layer is interrupted on either side by the pneumathodes which extend the whole length of the stipe and rhachis (Figs.19 to 22 and Figs.25 to 28). In many ferns the pneumathode is visible as



FIGURES 19–24. Anatomy of scandent frond of *Maxonia*. **19**: T.S. base of stipe, X 10. **20**: T.S. mid stipe, X 10. **21**: T.S. top of stipe, X 10. **22**: T.S. mid rhachis, X 10. **23**: T.S. costa, X 20. **24**: T.S. costule, X 20. In vascular traces: solid black = xylem; broken line = endodermis; continuous line = phlobaphene-containing cells.

a conspicuous yellowish streak but in *Maxonia* it is not externally evident. Internally, however, the pneumathode is fully developed and consists of an area of parenchymatous cells which are loosely packed (Fig.18). In longitudinal section the cells are seen to be several times longer than they are wide and there are abundant intercellular spaces which communicate transversely with one another and also with the longitudinal spaces. Thus the pneumathode provides a means of gaseous exchange between the interior of the organ and the exterior. Coupled with this is the restriction of the stomata to only that part of the epidermis which overlies the pneumathode. Here the stomata are arranged in four or five more or less regular rows (Fig.16) instead of being scattered over the surface as is the case on the underside of the lamina (Fig.15). There is also a contrast in the shape of the epidermal cells, these having straight walls on the stipe and undulate walls on the lamina (Fig.15).

A typical vascular trace (Fig.14) has a central band of xylem with a broad patch of phloem lying on either side of it, the whole being surrounded by a pericycle and endodermis. The latter is unthickened except for the small casparian strip on the radial walls. The cells of the cortex immediately abutting onto the endodermis are heavily impregnated with phlobaphene which completely obscures some of the cells whilst only partially covering others. This pattern of phlobaphene distribution is typical of that found at all levels of the stipe and rhachis of the sterile and fertile scandent fronds and also of the middle and upper parts of the stipe of the terrestrial sterile frond. In the latter, however, the base of the stipe deviates from the typical pattern. Here, the cells immediately external to the endodermis develop phlobaphene only around the margins (as seen in T.S.) leaving a clear lumen (Fig.30). In my specimens the thickening is translucent and light in colour, contrasting markedly with the dense brown/black of typical phlobaphene. In the rhachis the phlobaphene is again light in colour and somewhat translucent but in this case is confined to a band on the inner tangential walls adjacent to the endodermis (Fig.31). At all other levels (including the costa) such cells are dense, dark and quite typical.

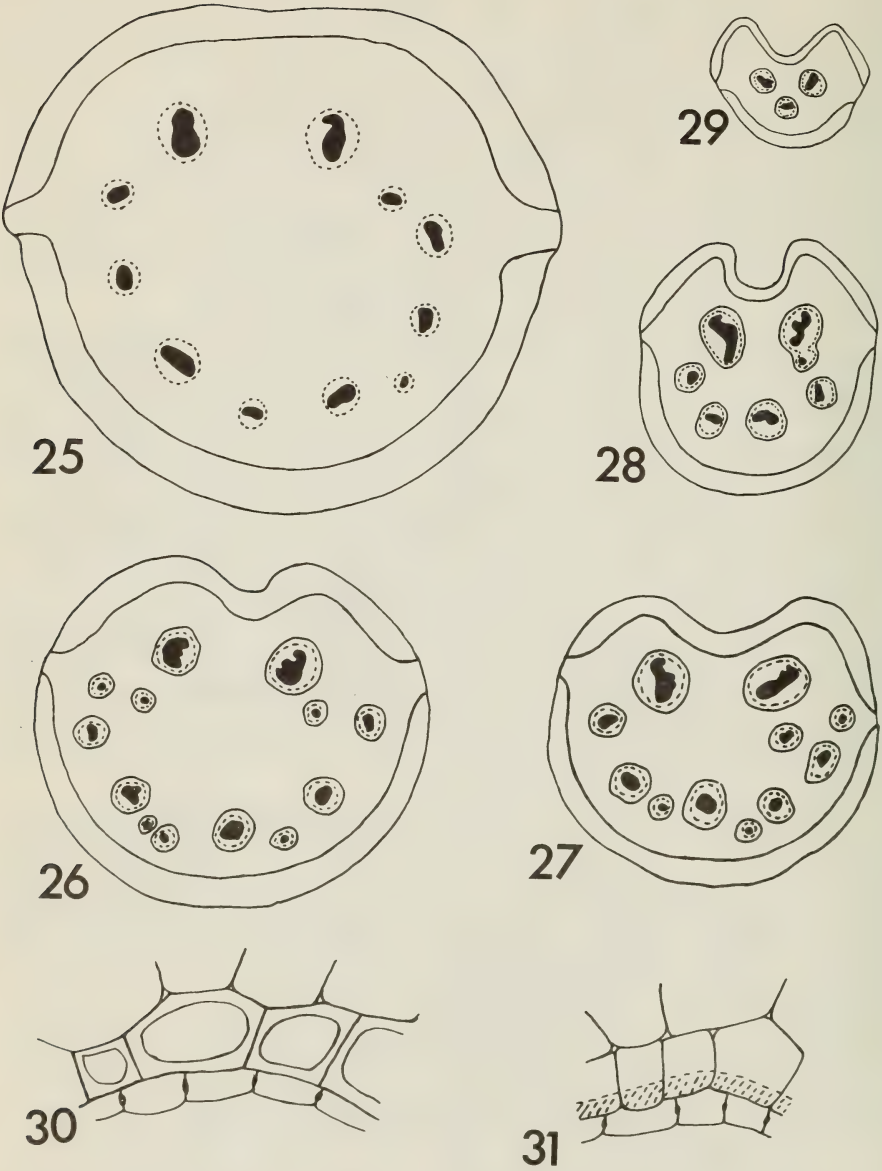
The frond vascular traces are relatively numerous when compared with those of many ferns of similar size in the Aspidiaceae and remain approximately constant in number throughout the stipe, although there are minor fluctuations from one level to another and it is evident from serial sections that a certain amount of splitting and anastomosing of the traces occurs. Normally five traces supply each costa, the number decreasing to three in the costules. This holds true for both sterile and fertile fronds despite the great reduction of the laminar surface of the latter.

In addition to the differences of phlobaphene development noted above, the terrestrial sterile fronds have stipes that are only about half the diameter of those of the scandent types (compare Fig.19 to 21 with Fig.25 to 27, noting the change in magnification). This reduction in size is accompanied by a reduction in the number of traces to approximately twelve, which is about half that found in scandent stipes.

The lamina in all cases is well provided with aerating tissue, although there is not a very sharp distinction between palisade and spongy mesophyll. Abundant stomata are present (Fig.15), confined to the lower surface of the frond.

DISCUSSION

Some at least of the changes that take place on the changeover from the terrestrial to the scandent condition can reasonably be linked with a change in the environmental conditions. Thus, the scales on the terrestrial rhizome (which is underground and not



FIGURES 25–31. Anatomy of terrestrial frond of *Maxonia*. **25**: base of stipe, X 18. **26**: T.S. mid stipe, X 18. **27**: T.S. top of stipe, X 18. **28**: T.S. mid rhachis, X 18. **29**: T.S. costa, X 18. **30**: T.S. endodermis and innermost layer of cortex of stipe base, X 210. **31**: T.S. endodermis and innermost layer of cortex of top of stipe, X 210. In vascular traces: solid black = xylem; broken line = endodermis; continuous line = phlobaphene-containing cells.

exposed to the air) are relatively small and are sparse except around the growing point which is most vulnerable to damage as it pushes through the soil. On the scandent rhizome (which is exposed for its entire length) the scales are about twice as large and form a thick protective layer over the whole of the rhizome and not merely at the growing point. Again, the flattening of the underside of the scandent rhizome and the partial moulding of its shape to conform with the irregularities of the underlying bark enables it to adhere more securely to the tree.

Presumably the fact that the fertile fronds are only produced on the scandent portion is also linked with an environmental change or stimulus but as to what this may be is a great deal less obvious. Two possible explanations readily come to mind but on closer examination neither seems to be entirely satisfactory when viewed in the light of field observations. One of the most obvious factors in the case of a fern which is rooted in the ground in the forest and climbs to the top of a tree is the difference in light intensity experienced. However, the idea of a change in light intensity being a determining factor in the production of fertile fronds must be dismissed as it does not agree with field observations. For example, one of the areas on Mt Diabolo has been denuded of trees and *Maxonia* is abundant here. In the centre of this area a three foot high fence post has been left standing and a plant has climbed up it, producing all the typical scandent changes and also a crop of fertile fronds. Clearly, in this case there was no significant difference in the light intensity experienced by the terrestrial and scandent portions of the plant. A similar case was noted in New Britain in the case of *Stenochlaena* sp.

HOLTTUM (1954a) considers that in the case of *Stenochlaena* the stimulus to become fertile is provided by a period of dry weather. This idea of dry conditions providing the stimulus can be extended to explain why fertile fronds are normally only produced on the scandent portions of the plant and not on the terrestrial parts in that *a priori* one would expect the former to be subjected to drier conditions than the latter at all times. The original idea and its extension are more difficult to prove or disprove by field observations but again the balance of the evidence is against them. Thus, a number of species of scandent and climbing ferns in Trinidad (where there are well-marked wet and dry seasons) do not become fertile in the dry season or at the beginning of the wet season but only when the rainy period is well advanced. Indeed, for many of them the dry season represents an interruption or resting period and it would appear that dryness does not provide the necessary stimulus. Furthermore, in Jamaica in some localities *Maxonia* grows in very well drained soil overlying porous limestone which dries out during occasional droughts. Under these conditions, moreover, the terrestrial portion is not stimulated to become fertile.

Such observations suggest that the terrestrial and scandent phases represent two different physiological states of the plant (perhaps somewhat analogous to juvenile and adult forms of some organisms) one of which is normally incapable of producing the reorganization of growth patterns etc. which the formation of fertile fronds demands whilst the other one is. This is consistent with the very striking and rapid changes which occur in *Maxonia* and other scandent ferns on passing from the terrestrial to the scandent phase and implies the existence of a drastic reorganization of the morphogenetic system which is coincident with the change of physiological state. The mechanism by which this reorganization is accomplished could conceivably be provided by the changeover from a diageotropic to a negatively geotropic manner of growth of the rhizome which may affect the distribution of hormones within the rhizome and its apex. It is well known that some plant hormones such as IAA may show marked changes in distribution within a tissue when the latter is subjected to a geotropic stimulation. These changes have consequent effects upon the patterns of growth.

The identification of the stimulus which triggers off the alteration in the geotropic response of the rhizome, together with an analysis of the morphogenetic patterns in the terrestrial and the scandent phases represent problems which would form a fascinating and valuable field of study.

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REVIEW

BOTANY OF THE PHILIPPINE LOWER PLANTS VOLUME 1 by P.M. Zamora. Pp. 147, 212 x 272mm, mimeographed by the author at Diliman, Quezon City, Philippines, 1971.

Dr P.M. Zamora has privately produced this invaluable book as a precursor to a more permanent and revised printed edition. He is to be congratulated. Whilst aimed at his students and colleagues in the University of the Philippines, it is the kind of manual that any University laboratory and library could well possess. The bulk of the work deals with Lycopsida and Sphenopsida; Filicopsida is, I assume, the subject of later volumes. Full descriptions are given on developmental morphology, anatomy, biosystematics and ecology; the bibliographies are extensive. The most stimulating part of the work is the frequent mentioning of unsolved problems yet to be tackled.

I should like to draw attention to a worthwhile periodical THE PHILIPPINE BIOTA produced by the Biology Teachers' Association of the Philippines (C/o University of the Philippines College of Agriculture, Laguna). This over the past few years has contained several papers by Dr Zamora and others on the morphology and biology of ferns. These publications are reflecting an upsurge of fern studies by Zamora and his colleagues Michael Price and Juan Pancho, and their students which is resulting in new knowledge from an area of great richness. Their efforts to evaluate and encourage others to join with them to evaluate, the fern flora of these islands before agriculture and de-afforestation have taken all are greatly appreciated.

A.C. JERMY

THE KARIBA WEED: SALVINIA MOLESTA

D.S. MITCHELL*

ABSTRACT

The rampant weed on Lake Kariba and elsewhere, hitherto called *Salvinia auriculata* Aubl., is now regarded as a separate species, probably of hybrid origin, and is here given the name *Salvinia molesta* D.S. Mitchell *sp. nov.*

In May 1959 small patches of a *Salvinia* which in all respects appeared to be *S. auriculata* Aubl. (SCHELPE 1970 et al.) were reported on Kariba Lake. The construction of Kariba Dam had brought about a lacustrine habitat with an increasing area of water available for colonisation and the ecology of the plant which soon assumed the characteristics of a weed have been reported by SCHELPE (1961). As more was learnt of its biology, morphology and taxonomy (see MITCHELL 1970) it was realised that it was not the same as *S. auriculata* Aubl. and it is now proposed that it be regarded as a distinct taxon, *S. molesta*. The purpose of this short note is to validate this name.

Salvinia molesta D.S. Mitchell **species nova.**

S. auriculatae, S. bilobae et *S. herzogii* affinis sed morphologia axis fertilis differt.

Partes vegetativae variabiles ut in *S. herzogii.* Axis fertilis ad organa submersa affixus, praecipue plantis aggregatis nascens; ramificatio scorpiodidea. Sporocarpia usque ad 55, ovoidea, apiculata, diametro 1 mm vel minus. Sporangia matura, plerumque, vacua. Sporae, ubi adsunt, persaepe deformes, variabiles. Massulae cavae in microsporangiis interdum adsunt. Macrosporocarpia duo (raro tres), proximalia pedunculata. Microsporocarpia, usque ad 53, sessilia vel subsessilia. Omnia sporocarpia sed macrosporocarpia densius trichomatibus praedita.

Type: Rhodesia, Lake Kariba, Ruziruhuru River Inlet, *Mitchell 1330* (B; BM; BO; BOL; BR; CAL; CHR; EA; GE; GH; K; LISB; LP; M; MO; NSW; P; PDA; PRE; RB; **SRGH, holotype;** US; WAG; Z.)

Other specimens seen:

BOTSWANA: Kasane, Chobe River, *G.E. Gibbs Russell* 1341 (SRGH).

KENYA: Kitale, Barnely H 170/57 (BM); Lake Naivasha, *Mitchell* 1187 (SRGH); Nairobi, Bally 11390 (K).

RHODESIA: Chirundu, Zambezi River, *Bates* sn (SRGH 97192); *Brewer* 182 (CAH); Lake Kariba, *Mitchell* 580 (SRGH), 668(K), 1099 (GE), 1193–1196 (LP), 1197–1208 (BM), 1209–1218 (LP); Umtali, *Chase* 4615, 5731 (SRGH); Victoria Falls, *Wild* 4851 (SRGH).

S. AFRICA: Knysna, Gouna Forest Reserve, *Mitchell* 190 (BOL, SRGH).

ZAMBIA: Lake Kariba, *Phipps* 2810 (SRGH); Ndola, *Town Engineer* sn (SRGH 134857); Kazungula, Zambezi River, *Exell, Mendonça & Wild* 1457 (SRGH); Katambora, Zambezi River, *West* 3050 (SRGH).

CEYLON: Negombo, serious weed in waterway, *J.E. Senaratna* s.n. (K); very common about Colombo, *Sledge* s.n. (BM).

INDONESIA: W. Java, between Tjibodas and Tjipanas, *Jermy* 7213.

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*Botany Department, University of Rhodesia, Salisbury.

BRAZIL: Rio de Janeiro Botanic Garden, *Kuhlman* 06124 (RB).
QUEENSLAND: Anakie rlway. dept. dam. *Stanton* s.n. (K).
WESTERN AUSTRALIA: Harvey, *Marchant* 253.

The Salvinia auriculata group (incl. *S. auriculata* Aubl., *S. biloba* Raddi, *S. hertzogii* de la Sota and *S. molesta* may be distinguished from other species of *Salvinia*, initially by the confirmation of the hairs on the apices of the papillae on the upper surface of the leaves. Here there are four (rarely two in depauperate specimens) uniseriate hairs united at their distal ends. *S. molesta* can be distinguished from the other three species by the presence of long, straight, secund chains of sessile to subsessile male sporocarps, 1mm or less in diameter, containing mostly empty sporangia.

S. molesta probably has a widespread distribution in the tropics where it generally behaves as an aggressive weed on standing waters. It is also probable that, identified as *S. auriculata*, it has been the subject of several previous studies, for example by KOPP (1936) and BONNETT (1955). One specimen has been examined in South America. This was a pressed specimen in the herbarium of the Rio de Janeiro Jardim Botanico that had been collected in 1941 from the Botanic Garden (*Kuhlman 06124*). At the same time, specimens of *S. biloba* and *S. auriculata* were collected from the Garden and this raises the possibility that *S. molesta* is a hybrid of horticultural origin. Though this is indicated by the plant's robustness (hybrid vigour) and its sterility, there is little indication of intermediate characters between *S. biloba* and *S. auriculata*. However, in some respects, the plant is intermediate between *S. biloba* and *S. herzogii*. Cytotaxonomic and chemotaxonomic studies of members of the genus may provide evidence which could support, or refute this theory of hybrid origin. In the meanwhile, consideration must be given to the possibility that this species may not occur naturally in S. America, though it is clearly of S. American origin.

Specimens of *S. molesta* from Lake Kariba and India (identified as *S. auriculata*) have been the subject of a cytogenetical study by LOYAL & GREWAL (1966). They have shown that a high proportion of the sporangia abort at the archesporial stage and, when meiosis does take place, the process is highly anomalous. They cite the number of chromosomes to be 45 and suggest that the species is a pentaploid.

During the past year, *S. molesta, S. auriculata* and *S. herzogii* have been grown in culture under similar conditions. All species produced sporocarps which were morphologically consistent in each case and the species could be regularly distinguished from one another.

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NOTES ON PHILIPPINE FERNS

M.G. PRICE*

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1. A SECOND PHILIPPINE DIPTERIS

The special significance of the genus *Dipteris* is that it combines characters of primitive gleicheniaceous ferns and advanced polypodiaceous ferns and also that it is very similar to several ancient fossil genera. The strange mingling of unevenly evolved characters added to its status as an isolated relic are strong reasons for placing *Dipteris* in its own family, as various authors have done. Results of a comparative study by WILSON (1959) attesting to the unique sporangial structure make that disposition imperative.

The most abundant and widely distributed species is *D. conjugata* and until recently it was the only member of the genus known from the Philippines. This note is to report the finding of a second species, on the island of Negros, which is situated near the center of the archipelago.

Dipteris lobbiana (Hooker) Moore, Index: 80 (1857); Holttum, Gdns. Bull. Straits Settl. 4:57, *t.* (1927); Ferns of Malaya 133, *t.* 54 (1955).

Polypodium lobbianum Hook., Hooker's J. Bot. 5:309, *t.* 11, (1853) *non* Hook. (1862).

Exsiccatum: Negros Oriental, Amlan Mts, Pasalan Falls, on stones along river bank, 500 m, *J. V. Pancho 5005. D. lobbiana* is known in the Philippines by only this single collection. It has previously been recorded from Sumatra, the Malay Peninsula, Kalimantan, Sarawak, Sabah, Sulawesi and Amboina, and has of late been reported by VAN STEENIS (1971) from East New Guinea.

Holttum (1927) provides a photograph of this species in its typical floodswept habitat along with a discussion of its ecology and relationships. For its genus, *D. lobbiana* exhibits the greatest number of characters considered primitive, but some of these are possibly later adaptations to its rigorous environment, and derived rather than archaic. Our plant has segments only 4–5 mm broad, at the lower limit of the range of variation (5–10 mm) indicated by Holttum (*l.c.*), but I can detect no other disparity with his description.

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Note: Collections cited in this paper are deposited in the Herbarium, University of the Philippines at Los Banos (CAHP) unless indicated otherwise. Duplicates are being distributed.

2. THE TYPE LOCALITY OF CTENITIS RIZALENSIS

Ctenitis rizalensis was described by H. Christ in 1906 and then again in 1907. In the latter, he cited three collections, the first two being from Mindanao, the major southern island of the Philippines, and the last from Luzon, the major northern island. None of these three was designated as type nor was any reference made to the 1906 publication.

Copeland (1910), while reporting on another collection of this species from Mt Apo, Mindanao, the locality of the first collection cited by Christ in 1907, stated that Mt Apo was the source of the type. In 1929, he altered this opinion and elected San Ramon, Zamboanga, also in Mindanao, from where had come the second specimen of Christ (1907), which was actually the earliest collection. By 1960, Copeland had become positive that San Ramon was the type locality. The Luzon plant, which he had not seen, was dismissed as doubtful; Christ had said it was "a smaller form". That the name *rizalensis* was taken by Christ from the province of Rizal in Luzon was unheeded.

The matter is conclusively clarified by consulting Christ's original 1906 publication. The solitary collection mentioned was from Rizal Prov., Luzon, and it was specified that the type had been deposited in Christ's personal herbarium which is now at Paris. Recent collections from Luzon serve as confirmation and leave no doubt that the Mindanao plant is conspecific.

Ctenitis rizalensis (Christ) Copeland, Gen. Fil. 125 (1947); Fern Fl. Philip. 2: 290 (1960).

Dryopteris rizalensis Christ, Bull. Herb. Boiss. Ser.2, 6:1001 (1906); Philip. J. Sci. 2C:216 (1907); Copel., Leafl. Philip. Bot. 3:806 (1910); Philip. J. Sci. 40:294 (1929).

Rhizome short, stout, erect, bearing opaque brown acicular paleae 1–2 cm long and fronds to 135 cm long. Stipe slightly shorter than lamina, stout at base, densely paleate in lower portion, the paleae gradually modified upward from those of the rhizome to shorter, broader, and clathrate scales on the rachis. Lamina ovate, commonly 35–50 cm long by 20–33 cm broad and then tripinnatifid at base; base broadly rounded in outline; texture thick herbaceous; color beneath pale olive-green; eglandular. Stalked pinnae 4–7 per side, the lowest only slightly expanded basiscopically, the basal basicopic pinnule exceeding the longest acroscopic pinnule by about one-fourth. Dissection lax for the genus, segments becoming 5 mm broad before shallow crenations appear. All axes of the lamina bear greyish clathrate scales beneath, mostly oriented longitudinally. The main rachis, however, has numerous such scales on the upper side, oriented transversely and relatively broad, 3–5 mm at base. Sori medial or inframedial, indusium small, densely setulose.

Exsiccata: Luzon, Laguna Prov., Mt Makiling, in stable moist shade, 400–550 m, *M.G. Price 683, 932;* Quezon Prov., Llavac, *M.G. Price 950;* Sorsogon Prov., Mt Bulusan, *M.G. Price 1925.*

Endemic to the Philippines. The largest plants produce magnificent fronds, deeply quadripinnatifid. Distinguished from the related and common *Ctenitis setosa* (Presl) Holttum (*C. vilis* sensu Copeland, 1960) by the paleae of the rachis, the shape of the base of the lamina, and the ampleness and texture of the segments.

3. FIRST REPORT OF ACROSORUS FROM LUZON

As a genus, *Acrosorus* is in a precarious position, for although it probably is a natural group, it may be found not to deserve generic rank after a comprehensive study of the family Grammitidaceae is made. In provisionally accepting it here, I follow a conservative course.

The Luzon species, brought to my attention by Dr P.M. Zamora, and known only from recent collections, is:

Acrosorus streptophyllus (Baker) Copeland, Philip. J. Sci. 56: 480 (1935); Holttum, Ferns of Malaya 222, *t.* 121 (1955).

Polypodium streptophyllum Bak., J. Bot., Lond. 17: 42 (1879); C. Chr. & Holttum, Gdns. Bull. Straits Settl. 7: 298 (1934).

Rhizome short, bearing light-brown lanceolate paleae 2 mm long and linear fronds 3–11 cm. Stipe to 5 mm long to reduced basal segments. Lamina subcoriaceous, pinnatifid to *c.* 0.2 mm from the costa with entire segments. Sterile segments to 2 mm long, *c.* 1.5 mm broad just above base, varying from triangular and bluntly pointed with large sinuses to oblong and broadly rounded with narrow sinuses. Fertile segments to 3 mm long, confined to the upper portion of the frond, more strongly ascending than the sterile, each bearing a single deeply embedded sorus protected by the infolding of the apical portions of the segment from both sides which produces a much prominent ridge on the adaxial side. Veins one per segment, simple in lower segments and once forked near the base in the middle and upper segments; the acroscopic branch of the vein supplies a sorus. Hairs 0.3–0.5 mm long, stiff, mostly persistent, dark reddish-brown, solitary or in clusters of 2–3, borne along the costa, most numerous abaxially, and also along the margins of the segments. Sporangia not setulose.

Exsiccata: Luzon, Quezon Prov., Llavac, epiphytic on mossy trunks, scarce and mostly occurring as isolated individuals, 250–350 m, *P.M. Zamora 115, M.G. Price 1507*; Isabela Prov., San Mariano, 500 m, *H. Gutierrez PNH 78348.*

Our other species, known from Mindanao, Negros, and Mindoro, is *A. triangularis* (Scort. *ex* Bedd.) Copel., of which synonyms based on Philippine material are *A. exaltatus* (Copel.) Copel., *A. merrillii* Copel., and *A. symmetricus* Copel. It is possible that this should be combined with *A. streptophyllus*, as both are variable and the differences, as given by Holttum (1955), are mostly quantitative and may be due to age, environment, or ploidy; the latter would then be the correct name for all Philippine specimens. I am unfamiliar with *A. schlechteri* (Christ) Christ from New Guinea and *A. reineckei* (Christ) Copel. from Polynesia.

4. TWO ANTICIPATED THELYPTEROID FERNS

If a plant occurs to the south of the Philippines, in New Guinea, Sulawesi, or Borneo, and also to the north, in Taiwan, etc., it might well be expected to be present here. Thus Holttum (1955) predicted for *Thelypteris singalanensis*: "This species is certainly found in Sumatra, Malaya and Borneo; it is reported also by Ching from Formosa, in which case it probably occurs in some intervening territory." As anticipated, this fern has now been found in Luzon, where it is well established.

Thelypteris singalanensis (Baker) Ching, Bull. Fan Mem. Inst. Bot. 6: 334 (1936); Holttum, Ferns of Malaya 243, *t.* 138 (1955).

Nephrodium singalanense Bak., J. Bot., Lond. 18: 212 (1880).

Exsiccata: Luzon, Laguna Prov., Mt Makiling, in mossy forest near the summit, 1000–1100 m, *B.F. Hernaez 180, M.G. Price 319, 556, 1252, 1453*; Quezon Prov., Llavac, *P.D. Pages 4.*

The Philippine specimens are slightly larger than those described from Malaya by Holttum (1955), but are not otherwise distinguishable. The identification has been verified by Dr Holttum, who commented on the variability in size and revealed that the species also is known in New Guinea but by another name. According to Holttum's new division of the family Thelypteridaceae (HOLTTUM 1971), this species belongs in the genus *Metathelypteris.*

Holttum and Roy (1965) have reported the discovery in New Guinea of another thelypteroid fern, *Pseudophegopteris aurita*, already known from Southern China to India and from Mt Kinabalu in Sabah. Its presence in New Guinea greatly increased the likelihood that it occurs in the Philippines, as is now affirmed.

Pseudophegopteris aurita (Hooker) Ching, Acta Phytotax. Sin. 8:314 (1963); Holttum & Roy, Blumea 13: 131 (1965); Holttum, Blumea 17: 13 (1969).

Gymnogramme aurita Hook., Hooker's Ic. Plant. *t.* 974 (1854).

Exsiccatum: Luzon, Mt San Cristobal, in moist peaty soil at edge of bog-like crater lake, 1400 m, *M.G. Price 836.*

Known only by this one collection in the Philippines, which conforms in all respects to the description given by Holttum (1969).

5. CONFIRMATION OF VAGINULARIA PARADOXA

In excluding this species from the Philippine fern Flora, Copeland, p. 553 (1960), suggested that Hooker (1864) had attributed it to this country through a misidentification. Previously, both Beddome (1883) and Copeland (1905) had accepted Hooker's report, which was based on an unnumbered Cuming collection said to have come from Luzon. Then, Copeland (1907) told of receiving a specimen collected by Steere labeled Philippines, concluding that "The determination is correct, and this species should probably be added to our known flora". Finally, Christensen (1933) determined *Elmer 22124* from Mt Pinatubo, Luzon, to be *Monogramma paradoxa*; this collection is represented by two sheets in the Philippine National Herbarium. There have been several recent collections from Mt Banahaw, Luzon, where both Cuming and Steere are known to have botanized.

Vaginularia paradoxa (Fée) Mettenius, Ann. Lugd. Bat. 4: 174 (1869).

Pleurogramme ? paradoxa Fée, Mém. 3: 38, *t.* 4 (1852).

Diclidopteris paradoxa (Fée) Carr., Seem. Fl. Vit. 370 (1873).

Monogramma paradoxa (Fée) Bedd., Ferns Brit. Ind. Suppl. 24 (1876); Handb. 375, *t.* 214 (1883); Copel., Polyp. Philip. 106 (1905); Philip. J. Sci. 2C: 407 (1907); C. Chr., Leafl. Philip. Bot. 9: 3164 (1933).

Vaginularia junghuhnii Mett., Fil. Hort. Lips. 25, *t.* 27 (1856).

Monogramma junghuhnii (Mett.) Hook., Sp. Fil. 5: 123, *t.* 289b (1864).

Rhizome creeping, bearing dense lanceolate-acuminate toothed clathrate paleae 2 mm long, and narrowly linear fronds to 13 cm or more long, lamina indistinct from stipe. Fronds *c.* 1 mm apart, glabrous, entire, *c.* 0.8 mm broad, apex emarginate to bluntly pointed but seldom intact. Sorus single, narrow, continuous, borne along the costa between two indusial strips, extending to as close as 1 cm from both the base and the apex. Paraphyses hair-like, not broadened at tip, contorted, deciduous.

Exsiccata: Luzon, Mt Banahaw, on tree fern trunks in sheltered sites, 1000–1300 m, *B.F. Hernaez 2007, J.V. Pancho & B.F. Hernaez 3782, M.G. Price 885, 2112.*

The recorded range is from Ceylon to Polynesia and Taiwan to Australia, but the above description is based solely upon Luzon specimens. CHRISTENSEN (1943) regards the Polynesian plant as distinct from that of Malesia.

Vittaria and the dwarf ferns derived from it are in particularly urgent need of a modern revision. Among the dwarfs, *V. lineata* var. *trichodes* Christ, reported by COPELAND (1905) from Mindanao, and *Monogramma capillaris* Copel., described from Negros, were, through oversight, omitted by COPELAND (1960). I am not familiar with either.

6. THE IDENTITY OF TRICHOMANES MILLEFOLIUM PRESL

Although the *Trichomanes millefolium* of Presl is a later homonym and is therefore nomenclaturally illegitimate, it is usually assumed to be a taxonomic synonym of *T. maximum* Bl. Perhaps the only one to have doubted this was COPELAND (1933) who assigned it to *T. grande* Copel. with the remark: "Presl's *T. millefolium* was described with *'rhizoma...repens...'* which if accurate must apply not to this plant but to *T. maximum*. The only specimen cited was *Cuming 162*, of which all the specimens I have seen have an erect rhizome and fascicled stipes." In 1958, however, Copeland returned *T. millefolium* Presl to synonymy under *T. maximum*, without comment.

By courtesy of the late C.V. Morton, I have received on loan from the U.S. National Herbarium a sheet of *Cuming 162.* Three different species are represented: *T. grande* Copel., *T. apiifolium* Presl and a third, sterile but with indeed a creeping rhizome and bearing Copeland's undated determination, "*T. maximum* Bl. (?)." This last specimen is *T. obtusum* (Copel.) Morton, which I believe must be the plant described by Presl.

Dr R.E. Holttum has kindly searched the Kew herbarium for specimens of *Cuming 162,* finding three sheets, two bearing exclusively *T. grande* and the third consisting of a mixture of *T. grande* with what he believes to be *T. obtusum* lacking the rhizome. Where *T. obtusum* is found, it is invariably in association with the much commoner *T. grande*, but *T. maximum* is confined to higher elevations and was evidently never collected by Cuming.

The following is a comparative treatment of *T. obtusum* and *T. maximum*:

Trichomanes obtusum (Copeland) Morton, Cont. U.S. Nat. Herb. 38: 188 (1968).

Macroglena obtusa Copel., Philip. J. Sci. 84: 163 (1955).

T. millefolium Presl, Hymen.: 43 (1843); *non* Desv. (1827).

Involucre (indusium) 1.0–1.2 mm long by *c.* 0.5 mm broad; ultimate segments *c.* 0.8 mm broad in fresh material (dried material is usually curled and shrivelled); lamina (webbing) in axils of forks always less than 2 mm long; cells of hairs near rhizome apex yellowish between septae.

More compact, more finely dissected, generally smaller (fronds to 40 cm long) than *T. maximum*. All collections known to me have been from between 300 and 900 m. Endemic to the Philippines.

Exsiccata: Negros, *G.E. Edaño PNH 21369* (isotype, PNH), *21372;* Luzon, probably Albay Prov., *Cuming 162 partim;* Quezon Prov., Llavac, *M.G. Price 740;* Laguna Prov., Mt Makiling, *M.G. Price 1180, 1312, 1689.*

Trichomanes maximum Blume, Enum. Pl. Jav. 2: 228 (1828); Copel., Philip. J. Sci. 51: 217, *t.* 38 (1–4) (1933); Holttum, Fl. Malaya 2, Ferns: 107, *t.* 43 (1955).

Vandenboschia maxima (Bl.) Copel., Philip. J. Sci. 67: 54 (1938); Fern Fl. Philip. 1: 65 (1958).

Involucre 1.5–2.5 mm long by *c.* 0.8 mm broad; ultimate segments mostly *c.* 1.0 mm broad in fresh material; lamina in axils of ultimate and/or penultimate forks often over 2 mm long; cells of hairs near rhizome apex dark brown between septae.

Usually larger and more lax than *T. obtusum*, Philippine specimens to 60 cm long, Java specimens to 75 cm or more. All Philippine specimens with data have come from over 1000 m. I have seen a photo of the syntype from Java, *Zippel s. n.* (Morton Neg. No. 2422). Range from Thailand to Polynesia.

In sending me a loan of assorted specimens relating to this problem, Mr Morton included a photo (Morton Neg. No. 2423) of the holotype of *T. maximum* var. *minus* Bl., Enum. Pl. Jav. 2: 228 (1828), which bears Morton's remark that this variety was not mentioned by Copeland in his revision of *Trichomanes*. The photo shows a complete plant, readily identifiable as *T. grande* Copel.

7. A NEW SPECIES AND A NEW COMBINATION IN DIPLAZIUM

Diplazium egenolfioides M.G. Price, **species nova.** (Fig.1)

Ex affinitate *D. longissimi* (Copel.) C. Chr. necnon stipite rhachidique paleis copiosis nitentibus piceo-atris ornato, lamina semel pinnata, pinnis infimis reductis, axibus omnibus nigris; sed tamen paleis denticulatis, frondibus anguste ellipticis, pinnis majoribus, in lacinias dentatas uniformiter subtruncatas incisas, pinnis infimis breviter stipitatis, indusiis pallide brunneis distinguendo. Vide tabula.

Rhizome short-erect, bearing shining jet black linear-lanceolate toothed paleae to 8 mm long. Fronds to 50 cm long by 15 cm broad, very narrowly elliptic, pinnate, pinnae to *c.* 20 per side, the lowest gradually reduced. Stipes crowded, to 10 cm long below the lowest reduced pinnae, they and the rachises black and very densely paleate, with paleae like those of the rhizome. Lamina dark-green, paler beneath, drying dark, texture thin herbaceous, glabrous except for very small black paleae along pinna-costae beneath. Pinnae alternate, to 8 cm long by 2 cm broad, the lowest on stalks to 1 mm, the middle and upper sessile and then adnate, base truncate; reduced lower pinnae slightly deflexed, oblong, broadly rounded at the toothed apex; middle and upper pinnae lanceolate, acute, slightly falcate; basally each pinna is deeply cut, to over three-fourths of the way to the costa, the incisions becoming progressively shallower towards the merely toothed apex. Segments to 6 mm broad, regular, broadest on the basiscopic edge of the pinna, sides nearly parallel, apices subtruncate; veins to 6 mm broad, regular, broadest on the basiscopic edge of the pinna, sides nearly parallel, apices subtruncate; veins to four pairs, each terminating in a sharp marginal tooth. Small fronds from young plants are often less than 20 cm long with dimidiate pinnae 3 cm long, cut only about one-fourth of the way to the costa. The basal acroscopic segment is then developed into a small auricle. Sori extending from costule to margin or more commonly occupying only a small medial portion of the vein, usually diplazioid only on the lowest acroscopic vein in each segment. Indusium 0.5 mm broad, pale brown, margin slightly undulate. Spores pale brown, reniform, perispore forming a broad plane median wing.

Exsiccata: Luzon, Laguna Prov., Mt Makiling, local on steep slopes between peaks 1 and 2, in moist shade, 800 m, *M.G. Price 482,* **1762 (PNH, holotypus)**, *2089.* Living fronds simulate the gross appearance of sterile *Egenolfia rhizophylla* (Kaulf.) Fée (*Bolbitis,* Hennipman).

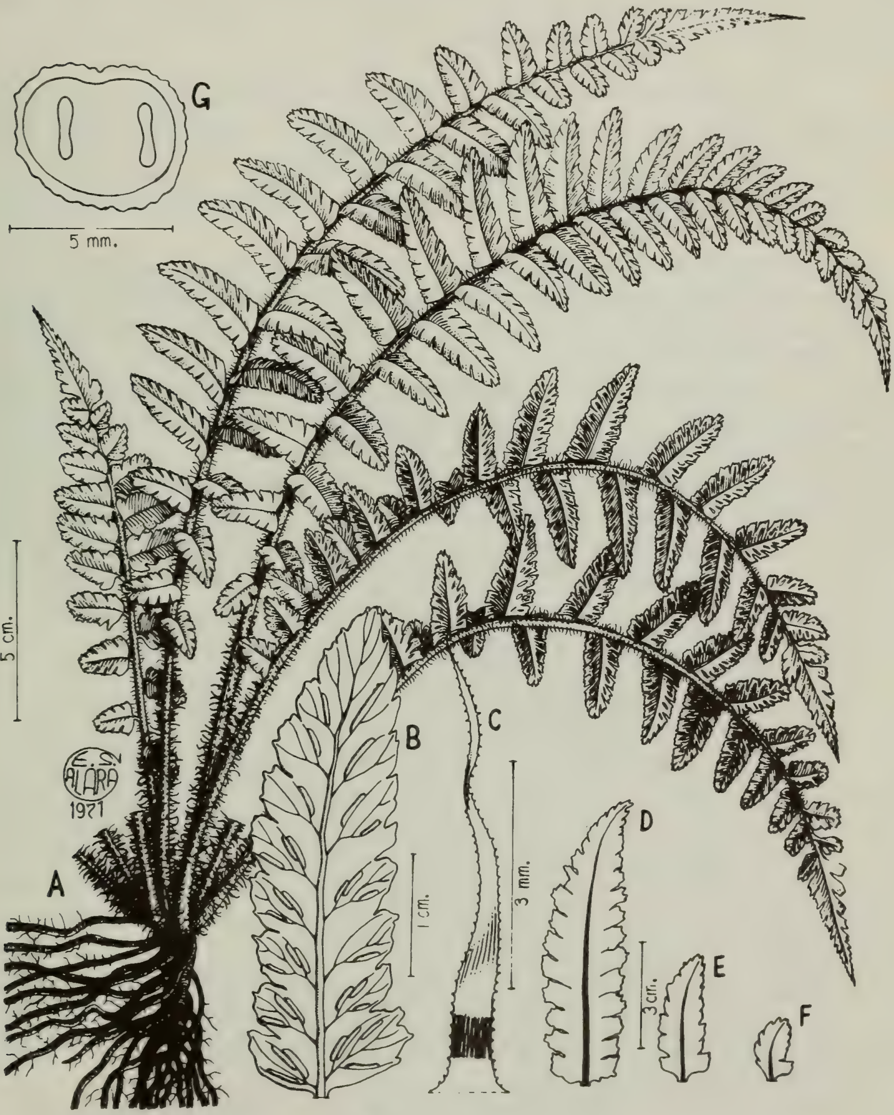

FIGURE 1: *Diplazium egenolfioides* M.G. Price **A**: Habit, medium-sized plant. **B**: Middle pinna from medium-sized frond. **C**: Palea from stipe base. **D, E, F**: Outlines of middle pinnae from large, medium and small fronds showing change in shape with change in size. **G**: Transverse section of stipe. Drawn by E.S. Calara from the type collection.

Diplazium egenolfioides belongs in the group discussed by Copeland (1947), comprising *D. acrocarpum* Ros., *D. altum* (Copel.) C. Chr., **D. fuliginosum** (Hook.) M.G. Price, **comb. nov.** (basionym: *Asplenium fuliginosum* Hook., Sp. Fil. 3: 120; 1860), *D. longissimum* (Copel.) C. Chr., *D. merrillii* Copel. and *D. porphyrorachis* (Bak.) Diels. This new species is the most dissected of the group and I believe it narrows the gap between the group characterized by narrow elliptic fronds and copious glossy black paleae, and the rest of the genus via especially *D. banahaoense* (Copel.) C. Chr., of which young plants have nearly the same frond form and blackish cast, but have fewer and brownish paleae.

8. TWO RARE FERNS FROM MT MAKILING NEW TO LUZON

Trichomanes rupicola Raciborski, Pterid. Buit.: 24 (1898); Copel., Philip. J. Sci. 51: 181, *t.* 19(2) (1933); *ibid.* 73: 466 (1940), *'rupicolum.'*

Crepidomanes rupicolum (Racib.) Copel., Philip. J. Sci. 67: 59 (1938); Fern Fl. Philip. 1: 73 (1958).

This attractive species was described from Java and later found in Mindanao. In Luzon, its only known locality is Mt Makiling, where it is found on the lower slopes, just above the campus of the University of the Philippines. It is a tiny fern, with the largest fronds only 21 mm long.

Exsiccata: Luzon, Laguna Prov., Mt Makiling, confined to shaded portions of large boulders along streams, forming dense mats above the reach of the flood, 100–200 m, *B.F. Hernaez CAHP 13248, N.M. Orlido 240, M.G. Price 1236.*

The epithet *rupicola*, meaning rock-dweller, is always used as a noun in apposition, and so must not be declined as an adjective (C.V. Morton, pers. comm.)

Tectaria beccariana (Cesati) C. Christensen, Ind. Fil. Suppl. 3: 177 (1934); Copel., Fern Fl. Philip. 2: 308 (1960).

Polypodium beccarianum Ces., Rend. Ac. Napoli 16: 30 (1877).

Aspidium bryantii Copel., Perk. Fragm. 3: 175 (1905).

Tectaria bryantii (Copel.) Copel., Philip. J. Sci. 2C: 412 (1907).

Aspidium bolsteri Copel., Philip. J. Sci. 1 Suppl.: 252 (1906).

COPELAND (1960) records this rare species from Mindanao and Negros, and implies that it may have been included with other species in *Cuming 356*, collected in Panay. There has been a report from Luzon under the name *Aspidium bryanti* by CHRIST (1906), containing brief information about a specimen collected by Loher on Mt Makiling in 1906. However, the fern described by Christ cannot possibly have been correctly named because of the specified indusiate sori and much narrower stipe wing; most probably it was *Tectaria grandifolia* (Presl) Copel.

Although characterized by exindusiate sori, this species is very intimately related to *T. vasta* of western Malesia, which has a persistent indusium as described by HOLTTUM (1955, p.512). Occasional sori on our specimens of *T. beccariana* do have minute vestigial indusia.

This is a fern of lowland rain forest, 250–350 m, the broad expanse of lamina serving to compensate for the low light intensity at the forest floor and the broadly winged stipes forming a humus-collecting basket.

Exsiccata: Luzon, Laguna Prov., Mt. Makiling, *M.G. Price 1425*; Quezon Prov., Llavac, *M.G. Price 758, 915.*

9. AN EARLIER NAME FOR PTERIS ASPERULA J. SMITH EX CHRIST

J. Smith (1841) published *Pteris asperula* without a description, basing the name on two Cuming Luzon collections, *253* from S. Ilocos which he designated as var. *caudata* and *413* from Zambales, designated as var. *ecaudata.* The species name was later taken up by Christ (1898), who published a brief diagnosis, virtually useless for distinguishing the plant, but sufficient to validate the name. Hieronymus (1914) followed with an elaborate description and was credited for the name by both HOLTTUM (1955) and COPELAND (1958).

Meanwhile, other names had been offered. Hooker (1858), quoting the same two Cuming numbers as did Smith, gave the fern varietal rank under *P. quadriaurita.* Copeland (1906) described a new species, *P. caesia*, which was soon reduced to *P. asperula* by Hieronymus (1914). Christ (1907) listed various Philippine specimens of this same taxon under *P. parviloba*, a name typified by a collection from the Asian mainland. Among the specimens enumerated by Christ was one collected by Loher at Montalban in 1890, quite likely the same as the one cited by him as *P. asperula* in 1898.

All authors seem to have ignored *P. oppositi-pinnata* Fée. CHRISTENSEN (1905, p.603), included it in *P. biaurita* L. along with *P. quadriaurita* and *P. asperula*; but in sorting these out, Hieronymus failed to account for Fée's name. Judging from the description, supplemented by a plate, I think this species can be nothing but the *P. asperula* of Smith, and it was in fact based on a Cuming collection from the Philippines, although without number. Thirteen years before publishing *P. oppositi-pinnata*, Fée (1852) had cited *Cuming 413* as *P. asperula*, but did not mention no. *253* which also had been quoted by Smith. I suggest that Fée's unnumbered Cuming specimen, the type of his new species, may well have been *Cuming 253*; in any case, I am confident of its specific identity.

Pteris oppositi-pinnata Fée, Mém. 10: 17, *t.* 13(3) (1865).

P. asperula J. Sm., J. Bot. 3: 405 (1841), *nomen nudum*; Fée, Mém. 5: 125 (1852), *nomen nudum*; Christ, Bull. Herb. Boiss. 6: 148 (1898); Hieron., Hedw. 55: 362 (1914); Copel., Fern Fl. Philip. 1: 141 (1958).

P. quadriaurita Retz. var. *setigera* Hook., Sp. Fil. 2: 181, *t.* 135a (1858).

P. setigera (Hook.) N.C. Nair, Bull. Bot. Surv. India 11: 187 (1971), basionym incorrectly cited.

P. caesia Copel., Philip. J. Sci. 1 Suppl.: 156 (1906); Fern Fl. Philip. 1: 142 (1958).

P. parviloba Christ, Philip. J. Sci. 2C: 172 (1907), as to Philippine specimens.

Distinguishing characters: fronds reddish when young, maturing to a dark greyish-green; pinnae all broadest at base (basal basiscopic segment always longest), sessile except for the lowest, cut to *c.* 0.2 mm from the costa into blunt mucronulate segments commonly 10–15 mm long by 2.5–3 mm broad, with caudate apex 1.5–5 cm long; terminal pinna longest and broadest, truncate at base, not at all decurrent; paleae at stipe-base linear-aciculate, foscous with a very narrow pale marginal fringe, to 8 mm long; frond everywhere rough, with stipe and rachis muricate, costae and costules spinulose, veins raised above and segment margins recurved and cartilaginous.

Apparently endemic to the Philippines. The Peninsula plant named *P. asperula* by HOLTTUM (1955, p.406), differs in several respects and should not, I believe, be included when this species is strictly interpreted.

By courtesy of the Director of the Botanic Gardens and the Curator of the Herbarium, Singapore, I have been able to examine specimens of *Cuming 253* and *413*. They are nearly identical and are both *P. oppositi-pinnata.* No. *253,* var. *caudata* of J. Smith, has caudae to nearly 5 cm long. No. *413*, var. *ecaudata*, of which there are two sheets at SING, is hardly ecaudate, having caudae up to 3 cm long.

10. THE GENUS LAGUNAEA VIDAL

Lagunaea was described as a new fern genus by Vidal in 1886 and has passed unnoticed since, escaping even CHRISTENSEN (1905). Vidal's name is illegitimate, the genus is a taxonomic synonym, and no species name was ever assigned to it, but the matter is of some interest because Vidal's Spanish description is the earliest record of a very peculiar enedemic Philippine *Tectaria.*

Tectaria dolichosora Copeland, Philip. J. Sci. 38: 136 (1929); Fern Fl. Philip. 2: 311 (1960).

Lagunaea Vidal, Rev. Plantas Vasc. Filipinas: 307 (1886), *non* de Loureiro (1790) = *Polygonum* L.

Vidal provided a fine description, considering this was the only fern he ever described, comparing the species to *Nephrodium melanocaulon* (= *Tectaria*, Copel.) as did Copeland (1929). He correctly described the sori as terminal on free veins, but these are included within areolae.

The idiosyncrasy of this species is an elongate indusium. Although elongate indusia are not unique in tectarid ferns, each case has been given a generic name; comparable indusia are also features of *Tectaria blumeana* (Regal) Morton, presumably from Java, and **Tectaria kehdingiana** (Kuhn *ex* Luerssen) M.G. Price, **comb. nov.** (basionym: *Luerssenia kehdingiana* Kuhn *ex* Luerss., Bot. Centralbl. 11: 77; 1882) from Sumatra, of which I have seen a specimen at Singapore.

ACKNOWLEDGEMENTS

I am indebted to the following for access to facilities and/or assistance with literature and specimens: Prof. J.V. Pancho, University of the Philippines at Los Baños (CAHP), Dr P.M. Zamora, University of the Philippines, Diliman, Quezon City (PUH), Dr R.E. Holttum, Kew (K), Mr C.V. Morton, Smithsonian Institution (US), Dr J.V. Santos (PUH), Mr E. Bardenas, Philippine National Botanic Garden (PNBG), and the Directors and Curators of the Philippine National Herbarium (PNH) and the Singapore Botanic Gardens (SING). I wish to thank the editors of the British Fern Gazette for valuable advice.

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THE ORIGIN OF ASPLENIUM BALEARICUM

J. D. LOVIS*, P. J. BROWNSEY*, A. SLEEP* AND
M. G. SHIVAS** (MRS TREVOR WALKER)

ABSTRACT

The synthesis of two new hybrids, *Asplenium haussknechtii* x *balearicum* and *A. kobayashii* x *balearicum*, is reported. Both combinations were obtained with unprecedented frequencies for hybrids between unrelated species. These hybrids show complete failure of chromosome pairing at meiosis, indicating that *A. balearicum* (and also *A. haussknechtii* and *A. kobayashii*) is of allopolyploid origin, and thus providing the evidence necessary to confirm the hypothesis of SHIVAS (1969), that *A. balearicum* is an amphidiploid species originating from hybridization between *A. obovatum* and *A. onopteris*.

INTRODUCTION

Three years ago one of us (M.G.S.) reported the existence of a tetraploid species of *Asplenium* in the Balearic Islands, distinct from either *A. adiantum-nigrum* L. or *A. billotii* F.W. Schultz, which was described as *A. balearicum* (SHIVAS 1969). In the same paper, cytogenetic evidence obtained from synthetic hybrids was presented which suggested very strongly that two diploid species, *A. obovatum* Viv. and *A. onopteris* L., were the parents of *A. balearicum*, a hypothesis which was clearly consistent with the morphological evidence. However, one piece of evidence was still needed to confirm the correctness of this hypothesis: a demonstration that *A. balearicum* was in fact of allopolyploid origin. It is the purpose of this paper to report on the cytology of two new synthetic hybrids which do indeed demonstrate that *Asplenium balearicum* is an allopolyploid.

The hybridization technique used was that described in detail by LOVIS (1968). In the cytological investigation, developing sporangia were fixed, stained, and preparations made permanent according to MANTON (1950, pp.295–6).

HYBRIDIZATION EXPERIMENTS

The new hybrids reported here are *Asplenium haussknechtii* X *balearicum* and *A. kobayashii* X *balearicum*, synthesized in November and December, 1970.

Asplenium haussknechtii Godet & Reut. (Fig.1) is a little-known and diminutive tetraploid species (Brownsey, Lovis & Reichstein, unpublished results) with a distribution centred on Asia Minor. Only very recently was it added to the European flora, having been found in Crete (ZAFFRAN 1970). It is clearly close to *A. lepidum* C.Presl of central and south-east Europe.

Asplenium kobayashii Tagawa (Fig.5) is a rare and inadequately studied taxon known only from Japan and Manchuria. Living material has been available to us from only one locality, and this collection, which is tetraploid, has recently been shown to be of rather spectacular origin, being derived from two very different diploid species, *Camptosorus sibiricus* Rupr. and *Asplenium incisum* Thunb. (Lovis & Sleep, in preparation).

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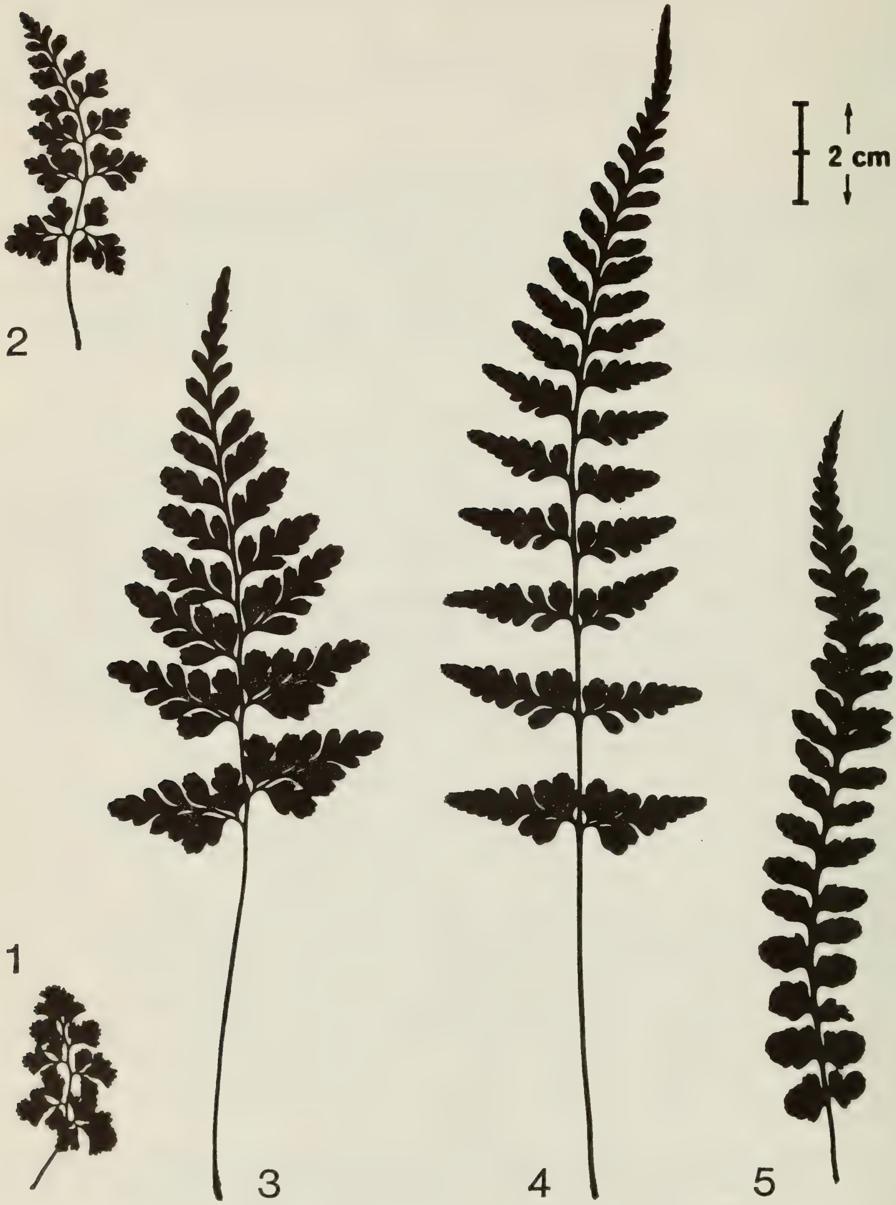

FIGURES 1–5: Silhouettes of fronds, 2/3 natural size, all from cultivation at Leeds. **1**: *Asplenium haussknechtii*, TR 1628. **2**: *A. haussknechtii* X *balearicum*, PJB 1A. **3**: *A. balearicum*, O'Nians culture. **4**: *A. kobayashii* X *balearicum*, JDL 2214A. **5**: *A. kobayashii*, JDL 2206E ex AS/257.

ASPLENIUM HAUSSKNECHTII ♀ X A. BALEARICUM ♂

Hybridization No.	Date	Prothalli	Hybrids	Selfs
PJB 1	11 Nov.	10	7	0
PJB 2	11 Nov.	10	6	0
		20	13	0

Percentage success: 65%

ASPLENIUM KOBAYASHII ♀ X A. BALEARICUM ♂

Hybridization No.	Date	Prothalli	Hybrids	Selfs
JDL 2205	11 Nov.	10	7	0
JDL 2206	11 Nov.	10	8	1
JDL 2207	25 Nov.	10	10	0
JDL 2208	25 Nov.	10	10	0
JDL 2213	31 Dec.	10	7	2
JDL 2214	31 Dec.	10	10	0
		60	52	3

Percentage success: 87%

CYTOLOGY

All three species involved in the hybridization experiments (*A. balearicum, A. haussknechtii* and *A. kobayashii*) are tetraploid and show a regular meiosis, with 72 bivalents present (Pl. XXVI).

Meiosis has been studied in five examples of *Asplenium haussknechtii* X *balearicum*, and in ten examples of *A. kobayashii* X *balearicum.* In both hybrids, all of the plants studied have proved to be tetraploid (as was expected) and show uniformly complete failure of chromosome pairing, 144 univalents being present in all cases (Pl. XXVI).

DISCUSSION

A. Interpretation of the cytogenetic evidence: the origin of Asplenium balearicum.

The total absence of chromosome pairing seen in *Asplenium haussknechtii* X *balearicum* and *A. kobayashii* X *balearicum* must mean that in both hybrids none of the chromosome sets possesses any effective degree of homology with any of the other three genomes present. It follows that the two chromosome sets contributed by the *A. balearicum* gametes are so distinct as to be incapable of pairing together, thus indicating an allopolyploid origin for *A. balearicum.* By the same reasoning, it also follows that *A. haussknechtii* and *A. kobayashii* must be of allopolyploid origin, a fact which in the case of *A. haussknechtii* has already been established by the study of other synthetic hybrids (Lovis, Reichstein et alia, unpub., Brownsey, unpub.), but which had not previously been determined for *A. kobayashii.*

Knowledge that the chromosome sets present in the gametes of *A. balearicum* cannot pair together confirms the interpretation given by SHIVAS (1969) of the patterns of chromosome pairing found in the series of synthetic hybrids obtained by her between *A. balearicum* and each of *A. adiantum-nigrum, A. obovatum* and *A. onopteris* respectively.

The relationships involved in all of the hybrids under discussion here can be symbolized as follows, where letters are used for chromosome sets, and the underlining bars indicate the constitution of bivalents formed at meiosis:

SPECIES:

A. obovatum:	$\underline{\text{Ob Ob}}$	*A. balearicum:*	$\underline{\text{Ob Ob}}\ \underline{\text{On On}}$
A. onopteris:	$\underline{\text{On On}}$	*A. adiantum-nigrum:*	$\underline{\text{On On}}\ \underline{\text{C C}}$
A. cuneifolium:	$\underline{\text{C C}}$	*A. haussknechtii:*	$\underline{\text{Y Y}}\ \underline{\text{Z Z}}$
		A. kobayashii:	$\underline{\text{S S}}\ \underline{\text{I I}}$

HYBRIDS:

A. haussknechtii X *balearicum:*	Y Z Ob On
A. kobayashii X *balearicum:*	S I Ob On
A. obovatum X *balearicum:*	$\underline{\text{Ob Ob}}$ On
A. balearicum X *onopteris:*	Ob $\underline{\text{On On}}$
A. balearicum X *adiantum-nigrum:*	Ob $\underline{\text{On On}}$ C

An important consequence of our new evidence is that it finally establishes that *A. balearicum* is distinct from *A. billotii* F.W. Schultz in its origin, since it is already clearly established that this latter species behaves cytologically as an autotetraploid (SLEEP 1966; GIRARD & LOVIS 1968; LOVIS & VIDA 1969). This is a point of some significance, because in the first published reports of Shivas' work on *A. balearicum* (quoted in MANTON 1961 (p.117) and MANTON & REICHSTEIN 1962), this plant was referred to respectively as *A. obovatum* or *A. billotii*, names which we now know to have been incorrectly applied to her material. This error has since been corrected (GIRARD & LOVIS 1969), but because a certain amount of confusion still persists in the European literature (MEYER 1968, 1969), it is desirable to take this opportunity of reviewing our knowledge of this group of species as represented in western Europe. There are four tetraploid species which are sufficiently similar in morphology to produce some taxonomic confusion, at least in atypical states. These, however, are all of distinct origin, as indicated below:

A. adiantum-nigrum ←——— *A. cuneifolium* X *onopteris* (SHIVAS 1969).
A. balearicum ←——— *A. obovatum* X *onopteris* (SHIVAS 1969).
A. forisiense ←——— *A. obovatum* X *fontanum* (SLEEP 1966).
A. billotii ←——— *A. obovatum* sens. lat. (SLEEP 1966).

MEYER (1969) suggested that the plant studied by GIRARD & LOVIS (1969) in Guernsey was indeed an autotetraploid derivative of *A. obovatum*, but was not *A. billotii* sensu stricto. This latter species he interprets (MEYER 1968) as being the allotetraploid derived from *A. obovatum* X *onopteris*! Meyer's 1969 paper was evidently written while those of Shivas (1969) and Lovis & Vida (1968) were in press, and therefore inevitably in ignorance both of the description of *A. balearicum* as distinct from *A. billotii* (SHIVAS 1969) and Lovis & Reichstein's observation (quoted

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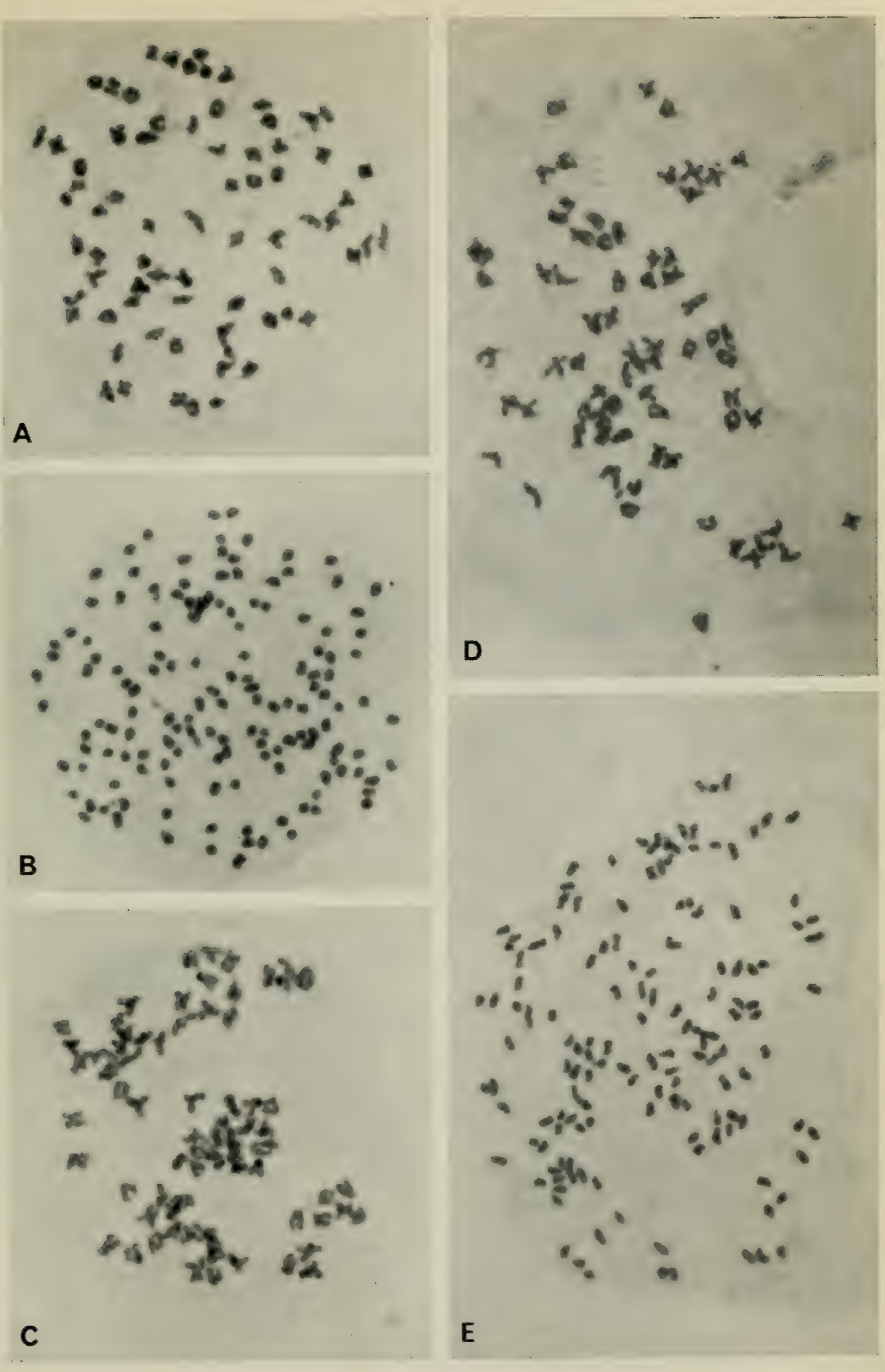
PLATE XXVI. Permanent acetocarmine preparations of meiosis. **A, C, D & E,** diakinesis; **B,** first metaphase. Magnification X 1000. **A:** *A. kobayashii,* JDL 2206E ex AS/257, showing 72 bivalents. **B:** *A. kobayashii* X *balearicum,* JDL 2205A, showing 144 univalents. **C:** *A. balearicum,* showing ca. 72 bivalents. **D:** *A. haussknechtii,* TR 1628, showing 72 bivalents. **E:** *A. haussknechtii* X *balearicum,* PJB 2C, showing 144 univalents.

PLATE XXVI



by Lovis & Vida, 1969, p.67) that the material of *A. billotii* from Ronco, Ticino, used in the resynthesis of *Asplenium* (X *Asplenophyllitis*) x *microdon* was morphologically very close to material from the *locus classicus* of *A. billotii* (Wasigenstein, Alsace), when cultivated side by side. The point at issue here is at least in part a rather unusual type of nomenclatural problem. The question of the nature of *A. billotii* can only be finally settled beyond all doubt by a demonstration of the cytogenetic behaviour of material from the type locality, and at present we still do not possess any such evidence. Nevertheless, it is worthwhile recording here that *A. balearicum* has now been cultivated in Leeds alongside plants of *A. billotii* originating from the type locality in Alsace, from Guernsey, and from Ticino. While the three *A. billotii* collections (two of which are known to behave cytogenetically as autoploids) are clearly seen to belong to one species, the *A. balearicum* culture maintains its morphological distinction from *A. billotii*, as described by Shivas (1969).

B. The synthesis of Asplenium haussknechtii X balearicum and A. kobayashii X balearicum.

The ease with which both of these hybrids were obtained deserves some discussion here, for in general, 'wide' hybrid combinations, i.e. hybrids between entirely unrelated species, have in our past experience never been easy to produce. Usually only a small or very small minority of the 'female' prothalli are successfully inseminated, and indeed, our experiments have quite often been entirely unsuccessful. In contrast, the degree of success recorded here is quite sensational, being unprecedented for any prior attempt to obtain hybrids between unrelated species*. In this connection, it is worthwhile recording that the highest percentage success previously achieved by any one of us for a cross between unrelated parents is 19.8% (*A. lepidum* X *adulterinum* Milde: 96 prothalli, 19 hybrids: Lovis, unpubl.)

In view of the entirely different character of the two parents, the success obtained (65%) with *Asplenium haussknechtii* X *balearicum* was surprising enough, but the result obtained with *A. kobayashii* X *balearicum* (87%) is perhaps even more remarkable, particularly as this level of success was maintained in six attempts over a period of seven weeks, and cannot therefore be dismissed as merely a fortunate accident. This outcome has a certain piquancy, for although this particular hybrid combination was obviously very desirable (it was evident that it might at one stroke yield a demonstration of allopolyploidy for two species, both currently under investigation) the initial attempts were undertaken primarily only as a demonstration of the technique of hybridization, and in a spirit of cynicism rather than with any serious expectation of success. The culture of *A. balearicum* employed was of unpromising appearance, already bearing young sporophytes when first used. The prothalli used as males were in fact a second crop which had grown up in the shade of the mature gametophytes. This same culture of *Asplenium balearicum* was used throughout the experimental programme, and it manifestly remained in excellent condition for at least seven weeks. This entire experience seems to show that it can sometimes pay to be optimistic in fern hybridization work.

We are not able to explain why the two hybrid combinations described here proved to be so unexpectedly easy to synthesize. At this point we should perhaps

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*An even more spectacular percentage success (214%!) has already been recorded for a hybridization experiment involving *A. balearicum* as a male parent (Shivas, 1969, p.78). 7 prothalli inseminated in the cross. A onopteris ♀ X *A. balearicum* ♂ yielded 15 hybrid sporophytes. Of course, in this case the parents were related.

emphasise that the technique used in these hybridization experiments in no way differed from that generally used at Leeds (LOVIS 1968), a method which has remained unchanged for a number of years now. It may be that *Asplenium balearicum* is an unusually amenable parent, and future experimentation with this species could resolve this point. It is certainly possible that the particular strain of *A. haussknechtii* used (*TR 1628*) is peculiarly compatible, since it has subsequently been incorporated in some other unlikely combinations with an exceptional frequency of success (Brownsey, unpubl.) Four attempts to synthesise hybrids between *Asplenium balearicum* and other cultures belonging to the *A. haussknechtii* complex were also made, but without success. It is however doubtful whether on this scale of effort a negative result has real significance.

ACKNOWLEDGEMENTS

We thank Prof. I. Manton, Prof. T. Reichstein and Prof. H.W. Woolhouse for their encouragement and interest. Prof. Reichstein we thank specifically for the material of *Asplenium haussknechtii* used in this investigation. We also thank the staff of the Experimental Gardens of the Botany section of the Plant Sciences Department in the University of Leeds, and especially Mr Peter Lee, Mr Frank Horwood and Mr Albert Henderson for their skilful care and devoted attention in looking after the prothallial cultures and the resultant hybrids. One of us, P.J. Brownsey, thanks the Science Research Council for a Research Studentship during the tenure of which his part in this study was executed.

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APPENDIX

Cultures used in hybridization experiments.

Asplenium balearicum: Balearic Islands; coll. E.A. O'Nians, 1952.

A. haussknechtii: Mt Spathi, Dikti Ori, Crete; coll. J. Zaffran, 19 (Zaffran 17, TR 1628).

A. kobayashii: Side of Tomari River, Mt Ohira, Hokkaido, Japan; coll. Anne Sleep, 1968, 1969. (AS/257, AS/941B).

THE DISTRIBUTION OF WOODSIA ILVENSIS AND W. ALPINA IN BRITAIN

MARTIN H. RICKARD*

Both *Woodsia ilvensis* (L.) R. Br. and *Woodsia alpina* (Bolton) S.F. Gray were much sought after during the middle of the last century (NEWMAN 1854 and others), and unfortunately seriously overcollected. Numerous whole plants were uprooted for herbarium and garden specimens leading to probable extinctions in several of the better known localities. Recently new records of these species have not been published because either the plants have been overlooked or their whereabouts have been kept secret for conservation reasons. I believe the former to be the main factor and the aim of this paper is to clarify the past status and distribution of these species in Britain and at the same time stimulate further searching to see if any of the apparently extinct records are still extant.

Several of the more common upland ferns have in the past been mistaken for Woodsias notably *Athyrium spp., Cystopteris fragilis agg., Dryopteris filix-mas agg.,* and in one case even *Asplenium billotii.* It is hoped therefore that the following guide will be of some use when identifying plants in the field:

Fronds may be of any size from 0.5 to 20 cm, usually 5 to 10 cm. The most conspicuous feature of the genus is the cup-shaped indusium which is characteristically split into narrow segments; distinctive vegetative features are few but fortunately both British species are rarely found sterile in isolation from mature sporing plants where examination of the indusium would allow certain generic indentification.

Key to the British species:

Frond lanceolate, hairy and chaffy (i.e. scaly) beneath, pilose above; pinnae oblong with usually 7–13 oblong segments; scales frequent on underside of rhachis and costae . . . . *ilvensis*

Frond oblong or linear-lanceolate, glabrous or only slightly hairy beneath; pinnae ovate or triangular with usually 3–7 obovate segments; scales on rhachis and costae few or absent . . . . *alpina*

Neither size of the plant nor number of pinnae segments are very constant characters; frond, pinnae and segment shapes are more reliable criteria. For example there are fronds of *W. alpina*, of garden origin, in the Kew herbarium measuring 17 cm in length with 11 or 12 segments per pinnae, while some fully mature fronds of *W. ilvensis* from Moel yr Ogof in North Wales are only 4.5 cm long and have only 6 segments on the largest pinna.

Forms, intermediate between the two species in some characters, are therefore quite frequent, particularly from central Scotland, but to date the hybrid (*Woodsia* X *gracilis* (Lawson) Butters.) has never been reported from the British Isles. It has been described from North America (cf. TRYON 1948) and Scandinavia (ROSENDAHL 1915) and may occur in Britain although the chances are small as both species rarely grow close enough in the same locality. However there are places where both species do occur together and hybrids may yet be found, notably near Moffat where E.J. Bennett in 1854 collected specimens of both species (all labelled *W. ilvensis* in error).

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*51 Rylstone Way, Saffron Walden, Essex.

Plants of *W. ilvensis* sometimes produce fronds like those of *W. alpina* according to Wollaston and Backhouse, jun. (in NEWMAN 1854, p.83). These plants may have been hybrids and if so could be partially fertile (see TRYON 1948, p.161) and may therefore be able to reproduce themselves or backcross to either parent producing a local population of hybrids. The author would be very interested to hear of any mixed populations of the two species or of localities where plants of possible hybrid origin occur.

In compiling the distribution data on both species the following herbaria have been consulted. The abbreviations in brackets are those given in *Index Herbariorum* (1964).
Aberdeen University (ABD); University of North Wales, Bangor (UCNW); British Museum (Natural History) (BM); Cambridge University (CGE); Royal Botanic Gardens, Kew (K); National Museum of Wales, Cardiff (NMW); Royal Botanic Gardens, Edinburgh (E); Glasgow University (GL); Manchester University (MANCH); Oxford University (OXF); and the museums of Carlisle (CLE), Dumfries (DFS), Perth (PTH) and St. Andrews (STA).

The ten kilometer grid reference is given after each locality.

1. WOODSIA ILVENSIS

WALES

V-c. 48 Merioneth
1 Precipices of Cader Idris 23/71
Specimens seen:— *J. Backhouse* 1877 (E); *Mrs E. Jones* 1894 (UCNW).
The first published record was by BACKHOUSE (1877). There are no recent records but the locality which was above Llyn Aran may still be extant.

V-c. 49 Caernarvon
2 Moel yr Ogof 23/54
Specimens seen:— *J.E. Griffiths* 1884 (NMW); *J.L. Williams* 1892 (BM), 1893 [as near Beddgelert] (BM, CGE); *H.J. Riddelsdell* 1904 (BM); *Sine coll.* 1913 (OXF); *J.R. Lee* 1931 (GL); *E. Vachell* 1935 (NMW); *H.F. Doraston* 1942 [as Moel Hebog] (K).
DYCE (1962) states that on the sheer wall of a perpendicular chimney nine plants were counted and these were seen by the author in 1971 but the species is very rare in this site.

3 Moel Lefn 23/54
Specimen seen:— *J.A. Whellan* 1942 (NMW).

4 Clogwyn y Garnedd 23/65
Specimens seen:— *W. Wilson* 1824 [as Snowdon] (GL); *Bowman* 1824 [as Snowdon] (E).
First record D. Lhwyd in RAY (1690). This was probably an error for *W. alpina* as specimens collected by Lhwyd from this locality in the herbaria of Oxford University and the British Museum are *W. alpina.* The first certain record is therefore based on the above herbarium specimens collected in 1824. NEWMAN (1844) illustrates fronds from this site which are undoubtedly *W. ilvensis*, but he believed even then that there were no specimens still in existance, indeed there have been no records of *W. ilvensis* from Snowdon since.

5 Above Cwm Idwall 23/65

Specimens seen:—*W. Wilson* 1824, 1826 (K, CGE), 1828 (GL, BM, K); *W. Borrer* 1837 (CGE); *'J.M.'* 1852 (GL).

In this vicinity there were several different colonies of this fern.

6 Above the pass of Llanberis 23/65

Specimen seen:— *Sine coll.* 1853 (K).

Latimer Clark (in NEWMAN 1854 p.77) describes the habitat as "rocks of peculiar character, resembling limestone, that crop out on the Glyder, there may have been a dozen small plants scattered over the rock which was barren, arid and exposed, and the plant seemed to be dwindling to extinction". The comment "dwindling to extinction" need not be taken too seriously as the dimensions of the plant vary considerably from summer to summer. Nevertheless, the plant does not appear to have been collected again from this locality.

TEESDALE

V-c. 65 North-west Yorkshire

Specimens seen without exact locality:— *W.W. Reeves* 1883 (BM); *J. Backhouse* without date (K).

7 Near Cauldron Snout in Yorkshire 35/82

No specimens. Ref. Potter in Baker (1854) and Moore (1859).

It has been generally assumed that Falcon Clints on the Durham side of the Tees was meant, but Cronkley Scar, which is in Yorkshire and where it is suggested by Baker that Potter collected it, is suitable. Other crags in the region could produce this fern but as yet *Woodsia* has never been recorded with certainty from the county.

There are also records from "Richmond" (BAKER & NOWELL 1854), and "near York" (specimen in CGE sin. coll. 1867); both these records are errors.

V-c. 66 Durham

8 Falcon Clints 35/82

Specimens seen:— *J. Backhouse* 1821 (E); *J. King* 1840 (MANCH); *G. Gibson* 1840 (BM); *R. Bowman* 1842 (BM); *J. Backhouse, jun.* 1844 (BM), 1881, 1883 (E); *J. Tateham* 1845 (BM); *A. Crosfield* 1884, 1892 (BM); *H.T. Mennell* 1895 (BM).

The earliest reference is in WINCH (1831, p.68) quoting J. Backhouse and S. Hailstone. The *Woodsia* grew on the basaltic rocks both at the base and at the summit. During the nineteenth century numerous botanists visited this site and by collecting caused wholesale destruction of the plant. At least one herbarium sheet collected from here shows eight whole plants mounted as a result of a single visit!

LAKE DISTRICT

V-c. 69 Westmorland

Specimens seen without exact locality: *F. Clowes* 1854 (K); *W. Crouch* 1862 (K); *Mrs East* without date (K). First unlocalised record — Huddart 1846 (LINTON 1878, p.151).

9 Helvellyn 35/31

Specimen seen: *Sine coll.* 1871 ["from a cultivated specimen originally collected on Helvellyn"] (OXF).

Ref: BAKER (1885) on the authority of Huddart and Clowes.

10 Hart Crag, Dove Crag, Fairfield, Scandale Fell and Red Screes 35/30 & 35/31
Specimen seen: *Sine coll.* 1862 [Fairfield] (OXF).
Ref: BAKER (1885) and WILSON (1938) quoting J. Coward and I. Huddart 1853–4.

11 Grisedale 35/31
Ref: WEISS (1930).

12 Ill Bell Range 35/40
No specimens seen. Ref: BAKER (1885) and WILSON (1938) both on the authority of Backhouse. It is surprising that no specimens have been seen from this locality as Backhouse has collected freely from other sites.

13 Head of Riggindale and Mardale 35/41
No specimens seen. Ref: BAKER (1885) and WILSON (1938) on the authority of J. Coward.

14 Crosby Ravensworth Church 35/61
No specimens seen. Ref: NEWMAN (1854) on the authority of T. Thompson, 1798. The church has now been demolished but the record was considered by WATSON (1883) to relate to the hills in the vicinity. If this is the case the altitude range of *W. ilvensis* may have to be revised as hills in this area are all relatively low (below 1400 ft).It is more likely a case of confusion of habitat.

V-c. 70 Cumberland
Specimen seen without exact locality: *F. Clowes* 1854 (K).
Some of the records for Helvellyn (locality 9) may be from Cumberland.

15 Scafell Range 35/20
Specimens seen: *D. Ratcliffe* 1954 (CLE).
Ref: LINTON (1878 p.151) and HODGSON (1898 p.366) both quoting I. Huddart and F. Clowes (1847 or 8). Apparently some 100 plants were present near Scafell on high slate crags. On the occurrence of *W. ilvensis* in the Lake District D.A. RATCLIFFE wrote (1960):– "It grows in at least one habitat in a dry earthy place and on moderately basic rocks with very sparse plant growth otherwise". There were originally about 100 plants with fronds measuring up to 7 inches in wet summers (see specimen at CLE) – one plant had a hundred fronds. Ratcliffe considers this probably the finest colony of this fern in Great Britain. This locality is almost certainly Huddart and Clowe's site.

16 Bowness 35/21
No specimen seen. Ref: LOWE (1859). This must be considered a doubtful record. I have not found it repeated in any subsequent publication possibly because it was assumed that the locality referred to was Bowness in Westmorland where there are no suitable hills. However the record may refer to the Bowness by Ennerdale Water in the neighbourhood of which are some fells of moderate altitude which could be a habitat for *Woodsia*, e.g. the crags on the north and south side of Great Borne.

The existence of so many Lake District habitats is rather suspicious especially the glib way in which they are enumerated in the Floras e,g, Riggindale etc. (WILSON 1938 p.267) as if the fern is common in the region. The present author has visited, although not thoroughly searched, this and several of the localities mentioned and found no *Woodsia.* A few plants of *Cystopteris fragilis*, with which it is occasionally confused, were however seen. Further suspicion is put on some records by their omission from the *Atlas of the British Flora* (PERRING & WALTERS 1962), e.g. Riggindale and Mardale; also specimens in the British Museum (Nat. Hist.) herbarium from the Lake District were immature fronds of *Dryopteris sp.*

If all the habitats given for the region are accepted as good no clear pattern emerges, it rather seems that *Woodsia* is likely to grow on any mountain among the crevices of the slate. The habitat described by RATCLIFFE (1960) is not a richly covered mountain ledge, but a comparatively uninteresting area and such an apparently unattractive habitat tends to be ignored by botanists thus contributing to the general failure to record the plant.

SOUTH SCOTLAND

V-c. 72 Dumfries

Specimens seen without exact locality: *E.J. Bennett* 1854 [as Ravine near Moffat] (BM, CGE); *D.A. Ratcliffe* 1954 (CLE).
The habitats in this area were described by Mr. Johnstone in NEWMAN (1854) as always occurring on rocks of western exposure in valleys running from north to south.

17 Devil's Beef Tub 36/01
No specimen seen. Ref: W. Little in NEWMAN (1854) "at 1200 feet".

18 Near Loch Skene 36/11
Specimens seen: *J. Backhouse* 1858, 1859 (E).
Ref: W. Little in NEWMAN (1854), and MATHISON (1881). According to Mathison the fern grows on rocks of a southern exposure at 2000 feet. SADLER (1857) refers to a "Woodsia ravine" this is possibly a ravine about Loch Skene.

19 Corriefron Glen 36/11
Specimens seen: *P.N. Frazer* 1857 (BM, E, ABD); *J.T. Johnstone* 1872 (CGE), 1889 (BM); *Sine coll.* 1909 (OXF).
Mrs. CARRUTHERS (1863) says the *Woodsia* is to be found "on rocks at the upper end of the glen". MATHISON (1881) reports it from the waterfall of Corriefron on rocks of a western exposure. The fronds in the Oxford herbarium claim to be from the sole remaining plant!

20 Saddleback (Saddle Yoke on O.S. maps) 36/11
Specimens seen: *P.N. Frazer* 1858 (BM, ABD).
This locality is very close to localities 19 and 21 but is probably distinct.

21 Blackhope 36/11
No herbarium specimens seen. A small population was located on the B.P.S. Excursion, 1972. Ref: Scott-Eliot (1896) on the authority of P.N. Frazer and J.T. Johnstone. This locality is the glen drained by the Blackhope Burn.

22 Whitecombe 36/11
Specimens seen: *W. Stevens* 1848 (BM, CGE).
The habitat was described as a rocky cleft near the Whitecombe.

23 Hartfell 36/11
Specimen seen: *P.N. Frazer* 1857 (ABD).
MATHISON (1881) describes the locality as "near Hartfell on rocks of a western exposure". This probably refers to the same area as the specimen in Aberdeen herbarium.

There is a specimen in the Edinburgh herbarium without collector's name, from "Near Beattock" collected in 1852. This is an unlikely way to describe any of the Moffat stations; nevertheless it is only just over a mile distant from Moffat, and probably does refer to one of the preceding stations.

V-c. 72/79 Dumfries/Selkirk

24 Hills on the Dumfries/Selkirk boundary

No specimen seen. Ref: Johnstone 1850 in NEWMAN (1854). These hills are 2 or 3 miles distant from localities 17–23, but the general form of the hills is rather different as they are rounded and less craggy, however the geology is broadly similar and there is every reason to believe that the *Woodsia* does still exist in this area.

NEWMAN (1854) wrote "the chief station in the United Kingdom for this fern [*W. ilvensis*] appears to be in the vicinity of Moffat and Kirkpatrick". He continued that W. Stevens, a correspondent of his, "found this fern in considerable abundance on very steep crumbling rocks amongst the hills dividing the counties of Dumfries and Peebles", in fact within four years Newman heard of 4 or 5 localities giving the impression of it being abundant there. This may have been the case but the *Woodsia* has since suffered so heavily at the hands of collectors that it is now extremely rare. SCOTT-ELIOT (1896) states that in 1856 there were hundreds of plants on Whitecombe, while at the time of his writing only two plants remained. After several explorations of this area the present author can only confirm the scarcity of the plant.

CENTRAL SCOTLAND

V-c. 86 Stirling or v-c 87 West Perth

25 Vicinity of Stirling

Ref: LOWE (1859). This record has been ignored by subsequent writers, but the Bencleuch range in v-c 87 (Grid ref. 27/90, altitude 2363 feet) could provide a suitable habitat overlooking Stirling.

V-c. 88 Mid Perth

26 Ben Lawers 27/64

Specimen seen: *F.A. Lees* 1872 (K).

Refs: J. Backhouse in LOWE (1876), Duckett and Worland (pers. comms. 1971). None of the literature records were accepted by PERRING & WALTERS (1962) confusion with *W. alpina* being suspected, but the existence of the herbarium specimen at Kew and the recent independent records are difficult to ignore. As this is such a rare species neither Duckett nor Worland collected voucher specimens of their records. BROWN (1964) cited a specimen of *W. ilvensis* from this locality in the herbarium of the Missouri Botanical Gardens, St. Louis.

27 Ben Chonzie 27/73

No specimens seen. Ref: Dr Balfour in LOWE (1876). This record may be an error for *W. alpina* which grows on the mountain.

V-c. 90 Forfar

28 Corrie Fiagh 37/27

Specimens seen: *Greville* 1824 [as Clova] (E); *J.D. Hooker* 1836 [Clova] (GL); *J.H. Balfour* 1840, 1846, 1847, 1859 (E); *H.C. Watson* 1844 (BM); *Sine coll.* 1846, 1882 (OXF); *Backhouse* 1849 (E), 1850 (K, E); *J. Roy* 1865 (ABD); *W. Evans* 1871, 1907 (E); *G.C. Druce* 1882 (BM, ABD); *W.A. Shoolbred* 1900 (BM); *Foggitt* 1911 (BM);

R.S. Adamson 1912 [as Glen Clova] (BM); *M.C.F. Proctor & K.M. Goodway* 1953 (CGE); *N.M. Pritchard* 1956 [as Clova] (ABD).
The plant is apparently luxuriant but rare here, there being "about a dozen plants tightly wedged side by side in a narrow crevice, (RAVEN 1956), this has been confirmed again in 1966 (Hamilton pers. comm. 1971) when there were two colonies.

29 Glen Isla 37/17
Specimen seen: *R.H. Williamson* 1923 (CLE).
Ref: Dr Syme in WATSON (1883). *W. ilvensis* is not included in the "Flora of Caenlochan", (ROGER 1954) and this is the most likely area in the glen where the *Woodsia* might grow, but it may have been overlooked.

[V-c. 92/93 Aberdeen
There is a specimen in the Kew herbarium from "Anchry House" (coll. *T. Frazer* 1875) which is mentioned in BROWN (1964). It is only included here to correct the error as this specimen is of garden origin.]

V-c. 95 Elgin
30 Near Forres
Specimen seen: *S.F. Gray* without data (K).
The area does not appear to be suitable for this fern, it is more likely that confusion of labels occurred. However this far north it is possible that a suitably alpine niche exists at a relatively low altitude.

WEST SCOTLAND

V-c 103 Mid Ebudes
31 Isle of Mull(?)
Ref: DRUCE (1932). This is an unlocalised record accepted by Perring & Walters (1962) on the basis of the *Comital Flora* record. The only suitable island appears to be Mull but the plant has not been re-recorded in the British Museum (Natural History) survey of the flora of Mull. This is almost certainly an error by Druce.

2. WOODSIA ALPINA

WALES

V-c 49 Caernarvon
1 Moel yr Ogof 23/54
Specimens seen: *J.E. Griffiths* 1884 (NMW).
GRIFFITHS (1895 p.167) quotes F.C. Roper as having found *W. alpina* "near Beddgelert" which may refer to this locality. PERRING & WALTERS (1962) record *W. alpina* for the 10-km square which includes this mountain since 1930, but this appears to be an error for the specimen of *W. ilvensis* (in NMW) collected by J.A. Whellan in 1942 (Hamilton pers. comm.). It is possible however that a specimen of *W. alpina* was collected at the same time.

2 Clogwyn y Garnedd 23/65
Specimens seen: *D. Lhwyd* pre 1690 (OXF, BM); *C. Parish* 1848 (E); *J. Kirk* 1849 (K, CGE); *J.M.* 1852 (GL); *T. Butler* 1855 [as Snowdon] (ABD, MANCH); *Miss Ridley* 1942 [as Snowdon] (BM); *E. Roberts* 1948 (NMW).

Refs: Numerous from RAY (1690 – collected by Edward Lhwyd) to DYCE (1962). The plant is now extremely rare here and inaccessible without ropes.

3 Pass of Llanberis on the NE side of Snowdon 23/65
Specimens seen: *Sine coll.* 1852 (GL); *W. Ingham* 1895 (NMW).
Refs: NEWMAN (1854) to Duckett (pers. comm. 1971). There appear to be several localities in this area, the *Woodsia* may still exist in all of them.

4 Near Llyn y cwn 23/65
Specimen seen: *W. Wilson* 1824 (GL).
There has been no record of this species in the locality since.

5 Cwm Bochlywd 23/65
No specimen seen. Ref: GRIFFITH (1895). This record needs confirming.

6 Carnedd range 23/66
No specimens seen. J. Duckett has reported (pers. comm. 1971) finding this locality recently. Climatically and edaphically there is no reason why the species should not be present in several places in the Carnedds.

LAKE DISTRICT

All the Lake District records are very doubtful, but there is no reason why *W. alpina* should not grow in the area.

V-c 69 Westmorland
7 Dove Crag, Fairfield 35/31
No specimen seen. Recorded in BAKER (1885) as "having been seen" there. WILSON (1938) did not include the record in his Flora.

8 Helvellyn 35/31
Specimen seen: *Knowleton* without date (K). this locality is prefaced on the herbarium sheet by a question mark. If it was not collected on Helvellyn it seems likely it came from the vicinity and presents the best evidence available for citing *W. alpina* as a Lake District plant.

[V-c 70 Cumberland
Kinprite
Specimen seen: *J. Taylor* 1860 (K). The locality is written "Kinprite Co. Cumberland" and is not included in standard Gazetteers of the British Isles. I suspect this specimen to be of foreign (probably the U.S.A.) or garden origin.]

SOUTHERN SCOTLAND

V-c 72 Dumfries
Specimens seen without exact locality: *E.J. Bennett* 1854 [Ravine near Moffat] (BM, MANCH).

9 Near Loch Skene 36/11
Specimen seen: *Sine coll.* and date (ABD).
Refs: NEWMAN (1854) and LOWE (1859). Both of which refer generally to the "Moffat Hills". Little, in Newman, expresses doubt over the existence of this species in the area, but Lowe shows no such hesitation. Subsequent writers, including

SCOTT-ELIOT (1896 p206), have omitted this record. Unless there has been some confusion of labels in the Aberdeen herbarium there can be little doubt that *W. alpina* did at one time occur near Loch Skene.

10 Whitecombe 36/11
Specimen seen: *J. Sadler* 1857 (DFS).
There is some confusion over this record as the locality and collector's name have been added at a later date.

CENTRAL SCOTLAND

V-c 87 West Perth

11 Glen Falloch 27/32
Specimens seen: *E.S. Marshall* 1890 (CGE, BM, PTH); *F.J. Hanbury* 1890 (BM).
Ref: WHITE (1898) on the authority of S. Grieve in 1888. There are several suitable hills on the south side of the glen, but this locality may be identical with locality 13 which is over the watershed of the River Falloch in v-c. 88, but E.S. Marshall has chosen to label specimens from both localities suggesting they are distinct.

V-c 88 Mid Perth

12 Ben Lui (Laoigh) in Perthshire 27/22
Specimens seen: *H.M. Drummond-Hay* 1874 (BM); *F.B. White* 1875 (PTH); *R. Kidston* 1879 (BM, E); *F.M.W. & R. Robinson* 1879 [as Tyndrum, Perth] (GL); *Sine coll.* 1911 (NMW).
Ref: White (1898). The specimen in NMW was collected at an altitude of 2300 ft. Some of the above mentioned specimens may have been collected in v-c. 98, Main Argyll, as the vice-county boundary bisects the mountain.

13 Cruach Ardrain 27/42
Specimens seen: *E.F. Linton* 1891 [as Corrie Ardrain]; *E.S. Marshall* 1891 [as Corrie Ardrain] (CGE); *A. Somerville* 1895 (E).

14 Ben More 27/42
Specimens seen: *Sine coll* 1905 [at 3480 ft] (NMW).
If this estimate of altitude is correct it constitutes an increase in the upper limit of this species so far recorded in the British Isles; the species has not otherwise been recorded above 3000 feet.

15 Creag Mhor 27/33
Specimens seen: *A. Somerville* 1897 (E); *J.R. Lee* 1929 (GL). Ref: WHITE (1898).

16 Beinn Heasgarnich 27/43
Specimens seen: *P. Ewing* 1892 (NMW); 1908 (CGE, K); *F.C. Crawford* 1902 (E).
It may have been common here at one time as the sheet in the Edinburgh herbarium contained 12 complete plants.

17 Meall a' Churain 27/43
Specimen seen: *P. Ewing* 1872, 1902 [as Meall Chirirn, Killin] (GL).

18 Stuchd an Lochain 27/44
No specimens seen. Ref: Hamilton (pers. comm. 1972) on the authority of E.C. Wallace, 1938. This is a large mountain and it is possible, but unlikely that *W. alpina* was recorded in 27/54.

Localities 19—22 are close together forming a chain of hills about four miles long.

19 Meall Dhuin Croisg 27/53
No specimens seen. Ref: Wilson 1827 (in NEWMAN 1854).

20 Creag na Caillich 27/53
Specimens seen: *J. Hardy* 1828 (MANCH); *A. Maingay* 1856 (MANCH); *J. Backhouse* 1859 (E); *Sine coll.* 1860 (OXF); *'A. McK.'* 1860 (GL); *'W.R.'* 1866 (ABD); *J. Roy* 1866 (BM); *E.F. Linton* 1882, 1884 (BM), 1883 (CGE); *F.C. Crawford* 1900 (E).
Ref: First record Wilson 1827 (in NEWMAN 1854).

21 Cam Chreag 27/53
Specimens seen: *J. Sadler* 1875 (ABD, BM), 1866 (E); *Sine coll.* 1883 [as Meall nan Tarmachan] (NMW); *F. Hanbury* 1888 (CGE, BM); *E.A. Richards* 1908 [as Meall nan Tarmachan] (BM).
Cam Chreag is a common name in Scotland and some of the herbarium specimens so labelled could possibly originate from the similarly named mountains at 27/3734 or 27/5348.

22 Creag an Lochain 27/54
Specimens seen: *Sine coll.* 1828 (E); *Graham* 1831(E); *J. Leitch* (coll.) 1869 (CLE); *B. White* 1875 (PTH); *F.M. Webb* 1878 (E); *W.R. & E.F. Linton* 1883 (BM, MANCH, ABD, E); *P. Ewing* 1883 (MANCH), 1897 (BM) 1910, 1912 (GL); *W.B. Wareterfall* 1885 (E, MANCH, BM, K); *W.G. Craib* 1885 (ABD); *G. Sim* 1893 (STA); *W. Young* 1893 (STA); *W.C. Warsdell* 1895 (K); *D.T. Playfair* 1900 (BM); *F.C. Crawford* 1900 [19 complete plants mounted] (E); *A. Somerville* 1900 (E); *Mc.T. Cowan* 1906, 1907, 1910 (BM), 1909 (MANCH), 1910 (K, E); *T.J. Foggitt* 1907, 1931 (BM); *R. & M. Corstorphine* 1907 (STA); *Sine coll.* 1910 (OXF, NMW); 1945 (STA); *J.R. Lee* 1915 (GL); *D.M. Henderson* 1953 (E).
Probably the best known locality for the species in Scotland but this population cannot however stand such intense collecting in the future.

There are specimens in CGE and BM collected on Catjaghiamman by J.T. Syme in 1851, this is possibly within this area (localities 19—22).

23 Ben Lawers 27/64
Specimens seen: *J. Dickson* 179— (BM, E); *Arnott* 1821 (GL); *J.H. Balfour* 1823 (GL), 1828 (BM, E); *W.J. Hooker* 1824 (K); *J. McNab* 1829 (BM); *Greville* 1837 (BM); *W. Wilson* 1836 (NMW, BM); *Graham* 1838 (GL); *F.J. Ivory* 1847 (E); *P.N. Frazer* 1856, 1862 (E, ABD); *Elizabeth Metcalf* 1857 (K); *W. Bell* 1860 (ABD); *J. Sadler* 1860 (E); *S. Sim* 1864 (MANCH); *J. Roy* 1866 (ABD); *F.B. White* 1862, 1872 (ABD); *F.A. Lees* 1872 (K); *P. Ewing* 1892 (GL); *C.E. Salmon* 1913 (BM); *W.A. Shoolbred* 1913 (NMW); *'D.R.'* 1921 (GL).
Ref: DICKSON (1790). "Ben Lawers" is quite likely an over generalisation of locality, no doubt many of these specimens were collected on Creag an Lochain (22) or An Stuic (24), however some were probably collected on Ben Lawers itself.

24 An Stuic 27/64
Specimens seen: *J. Dickson* 197— (BM); *J.H. Balfour* 1823 (GL), 1828 (BM); *Greville hb.* 1856 (E); *F.J. Hanbury* 1888 (BM); *S.M. McVicar* 1891 [as Ben or Meall Garbh] (BM); *C.E. Salmon* 1913 (BM); *E.S. Marshall* 1913 (CGE). There is a specimen in Hb. R.A. Graham collected in 1951 (Hamilton pers. comm. 1972).

25 Meall Ghaordie 27/53 or 54
Specimen seen: *E.S. Marshall* 1891 (CGE); *E.F. Linton* 1891 (BM).
There have been no recent records.

26 Ben Chonzie 27/73
Specimens seen: *J.H. Balfour* 1850 (E, GL), 1853 (E), 1854 (E); *Sine coll.* 1850 (BM); *D. Nichol* 1856 (E); *J. Bryce* 1859 (CGE); *F.B. White* 1861 (PTH); *Sine coll.* 1867 (OXF); *P.N. Frazer* 1867 (E).
In 1961 A. McG. Stirling reported *W. alpina* "rare on dry rocks at 2000 feet" (Hamilton pers. comm. 1972).

V-c 89 East Perth
DRUCE (1932) lists an unlocalised record. No specimen has been found to substantiate it.

V-c 90 Forfar
27 Glen Isla 37/17
Specimens seen: *Greville hb.* 1832 [as Caenlochan] (E); *J.H. Balfour* 1847 (E); *J. Roy* 1869 (BM, MANCH); *Sine coll.* 1923 (OXF). The most recent records are 1958 and 1966 by Dr U.K. Duncan (Hamilton pers. comm. 1972).
All these records probably refer to the cliffs above the Caenlochan Glen.

28 Glen Clova 37/27
Specimens seen: *H.C. Watson* 1844 [as Glen Fee] (BM); *Sine coll.* 1845 (OXF); *F. Naylor* 1863 [as Glen Doll] (BM); *Gower* 1873 (E).
NEWMAN (1854) quotes Balfour, 1847, from Glen Fiadh. The most recent record in 1967 from Corrie Fiadh by A.C. Jermy (pers. comm. 1972).

V-c 98 Main Argyll
29 Ben Lui (Laoigh) 27/22
Specimens seen: see locality 12.
This locality in Ciochan Beinn Laoigh which is partly in Perthshire, but it seems likely that the fern was found in the Argyll half (DYCE 1969). A.McG. Stirling (pers. comm.) confirms its occurrence in the Argyll half.

30 Coire Gamnhain 27/23
No specimens seen: Hamilton (pers. comm. 1971) has a record of it being found in 1950.

31 Meall nan Tighearn 27/22
Specimen seen: *E.S. Marshall* 1910 (CGE).

32 Beinn an Dothaidh 27/34
Specimens seen: *E.S. Marshall* 1893 (BM, CGE); *E.S. Marshall & W.A. Shoolbred* 1893 (NMW).
The post-1930 record for the square in the *Atlas of the British Flora* is an error.

V-c 92 South Aberdeen, 94 Banff or 96 Easterness
33 Cairngorms
Specimen seen: *J.M. Balfour* 1822 (GL).
This is a very doubtful record but could originate from the Cairngorms in any of these vice-counties. By 1823 (the next year) Balfour knew of the Ben Lawers localities, he may therefore have kept the record distinct on purpose. In addition, on a single record

card covering parts of v-cs 89, 90 and 92 J.G. Roger recorded *W. alpina* from "rocks of the Dalradian series" (Hamilton pers. comm. 1972), this most likely refers to v-c 90 but could be in v-cs 89 or 92. Glen Callater in v-c 92 is of a similar geological structure to both Glens Isla and Clova and may house this species.

V-c 104 North Ebudes
28 Isle of Skye
Specimen seen: *E.F. Linton* 1886 (BM).
This could be virtually anywhere on the upland portion of the island.

ACKNOWLEDGEMENTS

I would like to thank Miss N. Hamilton of the Biological Records Centre for her generous assistance, and also the curators of all herbaria consulted, for the loan of specimens.

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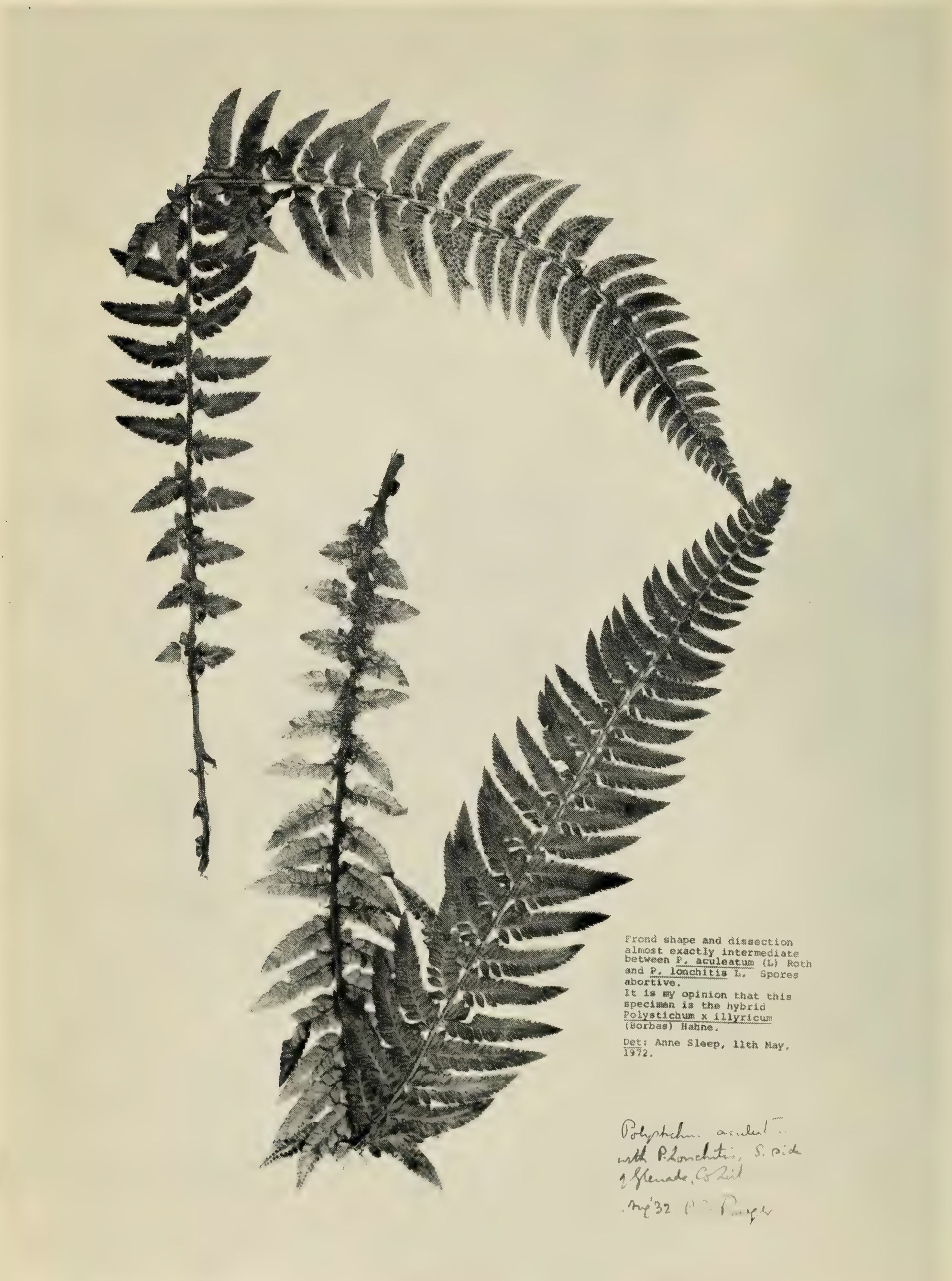
PLATE XXVII



Frond shape and dissection
almost exactly intermediate
between *P. aculeatum* (L) Roth
and *P. lonchitis* L. Spores
abortive.
It is my opinion that this
specimen is the hybrid
Polystichum x illyricum
(Borbas) Hahne.

Det: Anne Sleep, 11th May,
1972.

Polystichum aculeat.
with P. lonchitis, S. side
of Glenade, Co Leit
Aug '32 R. Ll. Praeger

POLYSTICHUM X ILLYRICUM: A HYBRID NEW TO THE BRITISH ISLES

ANNE SLEEP* & DONAL SYNNOTT**

In the last volume of the Gazette it was suggested that the hybrid *Polystichum* X *illyricum* (= *P. aculeatum* (L.) Roth X *P. lonchitis* (L.) Roth) might be found in the British Isles, and we are pleased to report here the realisation of this prediction. One sheet of a rather unusual-looking *Polystichum* came to light during a search for *Polystichum x bicknellii* specimens in the herbarium of the National Botanic Gardens, in Dublin (DBN), and on further examination this proved to be a fine specimen of the hybrid *P. x illyricum.*

This specimen was collected by R. Lloyd Praeger in August, 1932, and it bears the label "*Polystichum aculeatum*, with *P. lonchitis*, S. side of Glenade, Co. Leitrim". The sheet consists of two very fine mature fronds, both of which are intermediate in morphology between *P. aculeatum* and *P. lonchitis.* The fronds are 55cm long, narrowly lanceolate in shape, and rather stiff. Although simply pinnate, as in *P. lonchitis,* the fronds are deeply pinnatisect, and the pinnae in the middle third of the frond are again divided into tiny, acute, obliquely inserted pinnules, at least in the proximal part. Distally, the pinnae are entire, although deeply toothed. The proximal acroscopic pinnule tends to be conspicuous, and the pinnae are sickle-shaped, as in *P. lonchitis.* The spores are shrivelled and abortive, which confirms the hybrid nature of this specimen.

The discovery of this hybrid in Ireland is in itself rather remarkable, for one parent, *Polystichum lonchitis*, is very rare there, being confined to mountain cliffs in the west. It is, however, fairly plentiful on the limestone plateau of Ben Bulben, where it occurs at altitudes from 1,000 to 2,000 feet (300–600m). Glenade is a beautiful cliff-walled valley which intersects the Ben Bulben range. Extending in a north-westerly direction from the town of Manor Hamilton in County Leitrim, it is about 1,000 ft. deep and a mile wide, with a lake in its southern half. In places the massive cliffs are relieved by patches of woodland, although for the most part they consist of vertical cliffs with some free-standing crags, deep crevices and chasms and loose and overgrown limestone scree. The locality referred to on the label is almost certainly a mile or so of steep cliff to the north of the lake and on the western side of the glen. These north-east-facing limestone escarpments harbour a great number of rare alpines, including *Arabis petraea* and *Epilobium alsinifolium. Cochlearia alpina, Chrysosplenium oppositifolium, Silene acaulis, Draba incana, Dryas octopetala, Saxifraga oppositifolia, S. aizoides, S. hypnoides, Polystichum lonchitis* and *Asplenium viride* are among some of the other alpine species present. On the talus under these cliffs limestone scree is mixed with the remains of a former covering of peat, and ferns are unusually abundant and luxuriant, all of the following species being found within a relatively restricted area: *Polystichum lonchitis, P. aculeatum, P.* X *illyricum, P. setiferum, Dryopteris filix-mas, D. carthusiana, D. aemula, Athyrium filix-femina,*

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**National Botanic Garden, Glasnevin, Dublin, Eire.

PLATE XXVII. *Polystichum* x *illyricum* in herb. National Botanic Gardens, Glasnevin. (R.L. Praeger s.n.)

Oreopteris limbosperma, Blechnum spicant, Cystopteris fragilis, Asplenium trichomanes, A. viride, A. adiantum-nigrum, A. ruta-muraria, A. scolopendrium, A. ceterach, Polypodium vulgare and *Hymenophyllum wilsonii.*

P. X *illyricum* is the commonest *Polystichum* hybrid occurring on the continent, and is often found, sometimes in profusion, in the mountainous regions of central Europe. It *certainly could occur* elsewhere in the British Isles and it is hoped that the publication of this note on our find will stimulate pteridologists to search for this hybrid in other localities. It should be noted, however, that juvenile fronds of *P. aculeatum* can be very easily mistaken for *P.* X *illyricum*, as can small, stunted specimens of the same species growing in unfavourable habitats. If a microscope is available, quick scrutiny of the contents of a sporangium is the best method of positive identification.

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REVIEWS

SYSTEMATICS OF THE ONOCLEOID FERNS by Robert M. Lloyd. University of California Publications in Botany 61:1–86, 1971. 170 X 258mm. Price $3.50. [U.C.P. 2–4 Brook Street, London W1Y 1AA]

This paper provides a valuable and detailed account of the morphology and taxonomy of the genera *Onoclea, Onocleopsis* and *Matteuccia* and the conclusion that they should be reorganised as a natural group seems fully justified. They are compared very fully with both the Blechnaceae and the Aspidiaceae (in the broad sense of Copeland) and it is considered that they are related to the Aspidiaceae and are not ancestral to the Blechnaceae as postulated by Bower. This would probably be generally accepted, but some aspects of the discussion, dealt with below, do not seem entirely satisfactory.

The classification on which the argument is based is set out in a figure derived from one published by Wagner in 1969. The Aspidiaceae and Blechnaceae are placed in a group termed "Indusiatae" by Lloyd (together with the Dennstaedtiaceae, Lindsaeaceae, Aspleniaceae and Davalliaceae; and also the Hymenophyllaceae). Lloyd states (p.54) that it is not necessary to discuss the evolution of the sorus and indusium although, according to Bower's interpretation, which he accepts in full, the presence of a "false" introrse indusium in the Blechnaceae as opposed to a "true" extrorse indusium in the onocleoid ferns and the Aspidiaceae becomes an important distinguishing character. Since this interpretation was rejected by Christensen in 1938 and by Holttum in 1946 (with supporting argument) an adequate discussion should have been provided.

By the recognition of a group "Indusiatae" in a phylogenetic scheme it seems to be implied that the "true" indusium in these families has a common origin. The present reviewer would support this theory. It may be added here that the ancestral arrangement is apparently seen in *Dicksonia* and *Dennstaedtia* where the sorus arises from the marginal meristem and is protected by both dorsal and ventral flaps. In those genera (the majority) with superficial sori the dorsal flap has retreated with the sorus onto the lower surface of the leaf and has become the normally extrorse "true" indusium. In the "Gymnogrammoid" ferns of Lloyd's diagram, on the other hand, there is no trace of a "true" indusium. Those genera that have marginal sori (e.g., *Pteris, Pellaea, Adiantum*) usually have these protected by the inrolled and more or less modified leaf margin which is termed a "false" indusium. According to Bower the leaf margin in *Blechnum* has formed an introrse "false" indusium as in the "Gymnogrammoid" ferns. The heterophyllous species with contracted fertile pinnae (formerly assigned to *Lomaria*) are primitive and the expanded lamina of the fertile fronds of the homophyllous species and of other genera (e.g., *Woodwardia, Doodia*) is a secondary development. Lloyd accepts this derivation of the indusium in the Blechnaceae and also, apparently, this evolutionary sequence, although he does state that heterophylly cannot be used to show affinity between the Blechnaceae and the onocleoid ferns. Holttum, on the other hand, suggested that the sorus of *Blechnum* had been derived by the fusion of subcostal, virtually introrse sori such as can be found in *Asplenium*, together with the formation of costal areoles, and pointed out the significance of *Blechnum punctulatum* var. *krebsii* in this respect. He also regarded the heterophyllous condition as derived. The introrse indusium of the Blechnaceae would thus be homologous with the "true" indusium of the rest of the "Indusiatae".

If we return to the comparison of the three groups, which is facilitated by a useful tabular summary, it is evident that the Blechnaceae and the onocleoid ferns are markedly distinct from each other even when indusial characters are excluded. The author's main contention is thus well established. However, it may also be observed that, according to this table, there are no further major differences between the Blechnaceae and the Aspidiaceae *s.l.* apart from the development of the gametophyte, so that an estimation of the evolutionary (and taxonomic) distance between these two groups depends to a significant extent on the interpretation of the indusial structure. The final comparison to be made is that between the onocleoid ferns and the rest of the Aspidiaceae *sensu* Copeland and, as Lloyd states, this group fits well within the diversity found in this family. It is however this very diversity which blurs the discussion of the closer affinities of the onocleoid ferns. The Aspleniaceae were already split off from the Aspidiaceae by Copeland but the Thelypteridaceae and the Lomariopsidaceae are equally worthy of recognition, while the remaining genera fall into fairly well-defined groups. Recognition of these groupings — at whatever level — would have enlightened the discussion and more extended comparative studies within this alliance would be of great morphological and taxonomic value.

The suggestion of the hybrid origin of *Matteuccia intermedia*, a key species in Bower's supposed phylogenetic series, between the onocleoid ferns and the Blechnaceae, is of considerable interest.

FRANCES M. JARRETT

SOUTH AFRICAN POLLEN GRAINS AND SPORES Ed. E.M. Van Zinderen Bakker Part VI THE SOUTH AFRICAN FERN SPORES by Miss W.G. Welman. Pp. ix, 110, 1970, 16 x 24.5cm. Balema: Cape Town.

This volume follows others of the series where pollen of S African plants are described. The arrangement of families and the 75 genera is that of E. Schelpe's forthcoming monograph. There is a key to the "sporomorphae" fully described later in the text and a total of 262 species and varieties are covered, 75 of them clearly illustrated by drawings. The glossary describes the terms used very explicitly although it is clear that concepts may differ with different workers. References to other workers' descriptions are given under each species, however, and assuming the other worker's taxonomic concept is the same this is most useful. In Miss Welman's case, collector, number and herbarium where it is deposited are quoted for each specimen.

To a fern taxonomist anywhere this kind of book is invaluable. If descriptions of the spores of a cosmopolitan taxon is different to the one the reader knows there may be a regional (and intrinsic) variation which is worth investigating (e.g. *Anogramma leptophylla*).

Megaspores of *Isoetes stellenbossiensis* Duthie were not available to Miss Welman. Those on the syntype material (shortly to be designated lectotype) in the British Museum herbarium show a distinct sporoderm reticulate on both proximal and distal faces. The microspores are, under the S.E.M., verrucate with minute papillae both on and between the verrucae.

POLLEN AND SPORES OF CHILI by Calvin J. Heusser. Pp. xiv, 167, 1971. 23.5 x 31cm, University of Arizona Press, Tucson. Price $15.00.

Much the same may be said of this book as said of the above review, although Dr Heusser includes flowering plants and describes the microspores of 698 species, of which 54 are pteridophyta. Besides mainland Chile, Easter Island and Juan Fernadez are included. This work is illustrated by photomicrographs which are beautifully reproduced yet leave much to be desired — a gap that the S.E.M. will eventually fill. The study of palynology is essential to fern taxonomy and I welcome this book and more like it.

A.C. JERMY

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BRITISH FERN GAZETTE

VOL. 10 PART 5 1972

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The British Fern Gazette Volume 10 Part 4 was published on 15 October 1971.

Printed by Econoprint Ltd., Edinburgh.

THE BRITISH FERN GAZETTE

VOLUME TEN PART SIX

1973

THE JOURNAL OF THE
BRITISH PTERIDOLOGICAL SOCIETY

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EXPLANATIONS: HOW IT ALL BEGAN *

IRENE MANTON

I am glad of this opportunity to express publicly my very warm thanks to the Society for much kindness over many years and not least for the honour done me by the decision to devote two issues (for 1969 and 1970) of the *Gazette* (Vol 10 parts 2 and 3) to papers by my former students and collaborators. An apology is nevertheless perhaps also due to those members of the Society who (rightly) regard the intrusion of so much pure science as not pteridology in the old sense. This I willingly concede while recognising that an explanation might in fact be more helpful. I therefore propose to use the next few minutes to give you a brief case history, applied to myself, of how and why it happened and of how, indeed, I eventually came to write a book ("Problems of cytology and evolution in the Pteridophyta", 1950) which started off so many things and which some of you may know.

Chromosomes, which have become so prominent in the *Gazette* in recent years, were introduced to me first at school where I read Wilson (1902) on "The Cell" and found the book so enthralling, though tough, that I decided then and there that if the opportunity came my way in later life I wanted to count chromosomes. This was indeed a major reason why I chose botany rather than zoology as my main university subject, feeling that animals object more obviously than plants to being cut in pieces and I had no wish to annoy. The three years spent in Cambridge (1923–6) did not remove this ambition though I received no encouragement in it. At the end of the ordeal (I found it so) of obtaining a first-class degree, I was relieved to discover that I had not been permanently damaged, but how to begin to count chromosomes was no clearer to me then than it had been when I left school.

In 1926 my college awarded me its most highly endowed postgraduate studentship (with care one could live on £150 p.a. in those days) but where to go and how to begin involved difficult decisions which I was not informed enough to make unaided. In the end, with encouragement from Dr Kathleen Blackburn (cytologist) of Newcastle and Dr Hamshaw Thomas (palaeobotanist) of Cambridge, I chose Sweden. I therefore arrived in Stockholm in September 1926 to start research for a year in the laboratory of Professor Otto Rosenberg, a great cytologist of the old school who, in his youth, had been a pupil of Eduard Strasburger in Germany.

I learnt more from that year than from any other before or since. Not all of it was pleasant since I immediately became conscious that everything I did, whether sensible or silly, had to be carried out in full publicity before an observant and critical if friendly, audience. My educational background based on Cambridge was severely — and rightly — criticised. At lightning speed I had to fill in gaps. I learnt the language with some difficulty since even waitresses in cafés were more interested in practising their English than improving my Swedish. I was poor, since £150 though sufficient in those days to avert starvation was not a king's ransom. This in a sense was a help since it steadied my nerves which otherwise might have made me feel a worthless parasite on the community. Because, make no mistake, a beginner in research under such circumstances will flounder, since the problem of how to get started is made more difficult rather than easier by a change of country. Any raw student with a little imagination can think of many interesting problems worthy of solution, but the difficulty is to distinguish impossible problems from those which can reasonably be expected to yield to treatment under given circumstances. Only experience can make this distinction, which is why in our country we believe in so-called directed research for beginners so that the experience of the supervisor, directed especially towards the initial choice of a problem, can save the discouragement which arises inevitably from time-wasting and frustrating mistakes. I had no such supervision. Discouraging and time-wasting mistakes I had to make and it took me till mid winter to discard my most apparently interesting problems as impracticable and to settle down to a relatively humdrum cytological survey of chromosome numbers in one family of flowering plants, the Cruciferae.

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* Part of the Presidential Address given at the Annual General Meeting on 7 October 1972.

By this time Sweden was snowbound. I did on one occasion attack the frozen soil round a Shepherd's Purse plant *Capsella* with a hammer and chisel to obtain root tips for fixing to see whether cell divisions were still occurring in winter (bless me, they were) but this was a digression. My main source of material, for the rest of my time in Sweden, was root tips from seeds of botanic garden origin germinated on moist filter paper in petri dishes. I became expert in Strasburgian methods of embedding, sectioning and staining, mainly with haematoxylin though I substituted gentian violet after my return to England. The microtome I had to use was a continental rotary with an attached electric motor designed for a Singer sewing machine. This motor was the only sign of the twentieth century in that excellent and delightful laboratory. With it I cut yards and indeed miles of sections and ultimately completed my thesis for a Ph.D. on the chromosomes of 250 species of crucifers, all processed in this very laborious manner.

This taught me to count chromosomes, but only from sectioned roots, and I was as yet wholly without experience of meiosis, the process by which a chromosome number is halved in preparation for a new sexual fusion. The occasion for undertaking a study of this other side of cytology came unexpectedly and in a somewhat undignified manner. When my thesis on crucifer cytology was complete, the external examiner (the late Professor J.W. Heslop-Harrison, father of the present Director of Kew) detected a discrepancy which he was not slow to point out. In the text I had given one chromosome number, namely 32, as characteristic of the roots of watercress *Rorippa nasturtium-aquaticum* but in my drawings I had illustrated a cell with an entirely different number, namely 48. I had to confess bafflement but as soon as possible after the viva* was over (I was awarded the degree this notwithstanding), I made it my business to try to find out what could have happened. Being by then based on Manchester, I set out on my bicycle in the examination-month of June, to look for a wild watercress. This I duly found, flowering in a pond in a field, but when I examined its roots expecting to count either 32 or 48 chromosomes I was astonished to be confronted with an entirely new number namely 64. This at once introduced me to my first polyploid series, and all three numbers were included in my first paper which appeared in 1932 summarizing my thesis. In the subsequent follow-up, designed to ascertain the geographical distributions and other attributes of my three types of watercress in nature, I was able to show that they represent two good species and the sterile hybrid between them. This was the first but by no means the last occasion on which I added a new species to the British Flora by discovering its chromosomes first. It was also the first occasion on which I analysed meiosis to explain hybrid sterility on the one hand and as a source of phyletically significant information on the other. The enquiry, which was eventually published in two stages (Manton 1935a, Howard and Manton 1946), was an invaluable prototype study for much which followed later among ferns.

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* This viva voce was somewhat novel for another reason. Lincoln was chosen as a suitable central meeting place for the candidate and two examiners coming from opposite ends of the country. I suggested somewhere cooler than the railway platform and we sought the peace, as we thought, of the cathedral. In the event, the coolest cloistered calm was a builder's plank on two buckets. Here the discrepant chromosome numbers were questioned.

Whether, if left to myself, I would have spent the rest of my cytological life unravelling more of the many fascinating problems (such as that on *Biscutella,* Manton 1934, 1937) which abound among flowering plants can never be known, for I was in the event catapulted into ferns by a force beyond my control. When I joined the staff of the Botany Department of Manchester University as an assistant lecturer in 1929 I found myself in a uniquely favourable research environment. The department itself was small, comfortable and well equipped. There were even growing facilities for experimental plants which a botanic garden open to the public, such as that at Cambridge, was not designed to provide. The academic staff consisted of two professors backed up by no more than three lecturers and one assistant lecturer (myself). Both Professors (F.E. Weiss & W.H. Lang) were Fellows of the Royal Society and very active scientists and W.H. Lang in particular, first holder of the privately endowed research chair of Cryptogamic Botany, was an education in himself. Trained in Glasgow under F.O. Bower and an inspired teacher who would not tolerate pickled material (except for special purposes such as out-of-season Horsetail cones), Lang taught with authority, an experience that I had never had before. It was my privilege to act as his demonstrator for 12 years and this fact transformed my botanical life.

Lang's technical assistant was E. Ashby, trained at Chelsea Physic Garden and expert in the maintenance of a collection of living bryophytes and pteridophytes which Lang used for teaching to supplement local wild sources. Fossils of course could not be grown and these entered regularly into Lang's teaching alongside their extant relatives. For this also Manchester was unusually well endowed because there had been a long tradition of palaeobotany there as anyone visiting the stratigraphical hall on the ground floor of Manchester Museum will know. Lang himself had recently produced in collaboration with Kidston the splendid series of papers on Devonian plants of the Old Red Standstone (1917–21) introducing the Rhyniaceae, that most fascinating group of early vascular plants, now wholly extinct. It was not however these that first effectively drew me into ferns, since fossils after all make bad cytological material, but rather a request for help from Lang himself on a problem involving a living fern *Osmunda regalis.* Lang's own first paper (1898) had been on induced apogamy in ferns, a topic which had greatly intrigued the Glasgow department after the discovery of the cytological basis of alternation of generations. The demonstration of meiosis in spore mother cells of *Osmunda* and other plants (Strasburger, 1894) had indicated clearly enough that prothalli ought to be haploid and fern plants diploid. But what if meiosis were prevented? Lang had experimented further with this after moving to Manchester in about 1910 and had succeeded, with *Osmunda,* in circumventing meiosis by inducing prothalli to develop directly from the tips of young leaves by suitable experimental treatment. Such prothalli, if detached and laid on soil, grew on in the liverwort-like manner characteristic of *Osmunda* gametophytes generally, until sex organs developed with the eventual production of a new generation of young sporophytes.

In the middle of this experiment the first world war had broken out during which the experimental pans were neglected but not destroyed. When work on them could be resumed (Lang 1924) several young sporophytes were pricked out into beds in an unheated greenhouse and left to mature. At this point Lang wanted an answer to the question as to whether or not the chromosome number had been doubled in these sporophytes but he found himself inadequately briefed technically to do this. In 1931 therefore, he asked me as a supposedly trained cytologist, whether I thought I could do better. I did not know, never previously having handled a fern, but I agreed to try. I realised quickly that compared with most crucifers the chromosomes of *Osmunda* are large and that Lang's main mistake had probably been to instruct his assistant to cut exceptionally thin sections. By working as fast as possible, using my crucifer root-tip technique but cutting my sections thicker and staining them with gentian violet to make use of its transparency, I obtained preparations in about a fortnight which permitted the essential counting to be done in a week-end. I was at once able to complete a camera lucida drawing showing every chromosome in a dividing cell which had exactly 88 chromosomes as opposed to those of a normal root which has only 44. The chromosome number had indeed been doubled. Not all were however in this tetraploid condition since among a total of seven individuals examined I found two which were triploids with 66 chromosomes in their roots. These findings were published in 1932 as my second scientific paper though the follow-up took many more years and is in a sense still continuing (see for example Manton 1936, 1939, 1942, 1945a,b,c, 1950 etc and Manton & Smiles 1943).

The elegance of *Osmunda* as a source of cytological material, combined with the fact that a complete autopolyploid series (as opposed to the allopolyploid series represented by the watercresses) had spontaneously, as it were, arrived in my lap, would in themselves have sufficed to direct my attention forcibly to ferns. I have used this series for teaching purposes continuously throughout my life and I can strongly recommend anyone wanting to obtain an easy introduction to chromosomes to apply the simplest of the methods outlined in the appendix to my book to any available *Osmunda* plant, whether growing out-of-doors or in a greenhouse. The young croziers on outdoor plants carry out meiosis when they are about 10 inches high though second crop fertile fronds are commonly shorter at the critical stage. In an unheated greenhouse in Leeds, April 6 was a very common date on which fixations could be carried out, or with outdoor plants up to a month later, although naturally there is slight variation from year to year according to the weather. All known species of *Osmunda* have the same chromosome number and are in a sense interchangeable for cytological purposes. On the other hand the autopolyploid series in *O. regalis* is available only in culture in a few favoured places that know this material exists and how to obtain and propagate it. My own plants in Leeds are descendants of those which originated in Manchester, and other descendants are now at Chelsea Physic Garden, the Genetics Institute in Budapest with Dr Vida and doubtless elsewhere. Tetraploids can be multiplied at will by sowing spores from existing tetraploids, although this must of course be done in summer since the green spores lose their viability rapidly if they are not sown almost as soon as they fall from the sporangia. Triploids cannot be reproduced in this way but are not difficult to synthesise by inseminating diploid prothalli by normal haploid spermatozoids (as for example by the methods explained by Lovis 1968). As horticultural objects the triploids are superb, being larger than diploids. The tetraploids on the other hand are smaller and though they will grow out-of-doors readily enough in the climate of Manchester, it is probably safer to keep them in a cool greenhouse rather than exposed to the weather. All forms can of course be propagated by dividing the trunk of an old plant where branching has occurred.

Perhaps amusingly, some of the publications on *Osmunda* can be used to illustrate the progress of cytological techniques in the years leading up to the second world war. Anyone interested enough to compare the camera lucida drawings based on microtome sections, the only methods available for my papers of 1932, with the plates of a more extensive paper on *Osmunda* published in 1939, or indeed with chapter 3 of my book, will find that after 1935 photography is never absent and the technical methods themselves became more varied and quicker to apply. In almost every case the first application of a new technique was in flowering plants, but *Osmunda* was for me a test object of choice whenever a new method was successfully brought to my attention. In this connection 1935 was a key date in my cytological education.

In that year I visited Egypt for 3 weeks in the Easter vacation at the invitation of F.E. Weiss who had by then retired but was spending the academic year 1934–5 as Acting Professor of Botany at Cairo. During that visit I spent one day at the Cotton Research Station at Giza where J. Philp was chief cytologist. In his laboratory I saw for the first time some permanent stained slides of pollen mother cells in meiosis, prepared according to McClintock's method (i.e. Barbara McClintock a distinguished American corn geneticist). I brought a cyclostyled sheet of the details back with me, intent on following up an observation that I had made out of the corner of my eye (but which Philp appeared to disregard) namely that a few cells had become flattened and their contents spread out so that everything could be seen at one focal level. The importance of this to a photographer is obvious and the eventual solution of the problem of how to obtain such flattening at will is summarized in the paragraphs on aceto-carmine squashes contained in the appendix to my book.

Cytological photography, like so much else, I owe to Lang who had already pioneered its use in replacement of pencil drawings which previously had dominated palaeobotany. There is however a significant difference between photography of a fossil section viewed under a relatively low power with a dry lens and that of a stained chromosome seen under oil immersion, a type of lens that Lang never required. In the one there are always plenty of sharp outlines provided by cell walls or equivalent structures while there is no sharp outline to a stained chromosome seen under oil immersion near the limit of resolution with the light microscope, but only an opaque or coloured patch apparently floating in a light, or even a totally transparent, ground. Such an image, at first, Lang would not photograph.

I circumvented this difficulty by waiting until he was absent from the laboratory for a few days acting as external examiner to another university and then, with the help of his assistant Ashby and using the simplest of the laboratory cameras, I took my first cytological photograph. This was a polar view of a dividing cell in a root tip section of one of my crucifers *(Biscutella)* in which all of the 18 chromosomes present could be seen and counted at the relatively modest (to a cytologist) magnification of X 900. I showed the result to Professor Lang on his return and he was so thrilled that he took my negative home, set up his own enlarger in his study, and brought me next day some prints magnified to X 2700. (The very great are sometimes like that when they have been proved wrong by a junior). This picture was at once included in a paper then about to go to press (Manton 1934) and I used it again with good effect at the International Botanical Congress in Amsterdam in 1935. I have since taken many better pictures but none that was more important to me personally. The same year saw the publication (on flowering plant material) of my first paper based entirely on photography (Manton 1935b) though there have been many others since.

My next pteridophyte experience could easily have become my Waterloo. In those days, before the second world war, medical students had to be taught botany and this included the life-history of a fern as a vehicle for explaining haploid and diploid, syngamy and meiosis, the nuclear cycle in fact. I demonstrated for the medical class as well as for Lang, and the lecturer to the medicals had the bright idea of suggesting that the new assistant from Cambridge should be asked to prepare a cytological demonstration of the nuclear cycle in the Male Fern *Dryopteris filix-mas* for the benefit of this class. I had succeeded with the crucifers and with *Osmunda* so I said I would try. I applied the same methods but these were of little avail. I found that with some difficulty and a good oil immersion lens I could myself count approximately 160 chromosomes in a sectioned root (we now know that the number is exactly 164) but no medical student could reasonably be expected to work this out in class. I was scarcely in a position to interfere with the curriculum by substituting watercress or *Osmunda* so that for the next few years and indeed for all I know until the demise of the course, the chromosome cycle as applied to vascular cryptogams could be known to medical students in theory only. I had to accept defeat with a good grace (a cytologist must early learn patience) but for many years I regarded the ordinary garden ferns in general and the Male Fern in particular as impossible cytological objects, though I did not forget the experience without which I might in fact never have made my next pteridological discovery.

Lang's interest in apogamy had early introduced me to the work of a young German cytologist Döpp whose paper on the cytological basis of obligate apogamy in *Dryopteris remota* appeared in 1932. Shortly thereafter, by some means that I no longer remember, I was introduced to R. Lloyd Praeger (author of "The botanist in Ireland" and other books) who had recorded a specimen identified as *Dryopteris remota* in one particular locality in Ireland (Praeger 1909), *D. remota* at that time being accepted as a probable hybrid between the Male Fern and *D. spinulosa* (i.e. *D. carthusiana*). I visited this locality with Lloyd Praeger in the summer of 1936 or 7. We failed to find *D. remota* again but, as the next best thing, I brought back with me a descendant of the original specimen (which proved to be an apogamous triploid as explained in chapter 5 of my book and see Manton 1938) together with living wild plants of the putative parental species. Being however inexpert taxonomically, the plant I selected to represent *D. filix-mas* proved also to be apogamous with about 120 (actually 123) chromosomes in its roots instead of the 160 (actually 164) of my previous encounter in the medical class. I thereupon sent a frond for identification to the British Museum (Natural History) and received it back from the late A.H.G. Alston labelled *D. borreri* otherwise known as *D. filix-mas* var. *paleacea* or *D. pseudomas* Wollaston.

I looked up Wollaston's original paper (1855) hastily and was delighted to find that he, an amateur, had detected what he believed to be three distinct taxa confused together as Male Ferns in this country and, as many of you will know (see the Gazette for 1875), he had recommended use of the three specific names: *filix-mas, pseudomas* and *propinqua*. Since I was by now alerted to polyploid series it was clearly desirable to have a look at *propinqua* in relation to the two chromosome numbers that I had already found. Sure enough this worked out. A slightly crested plant labelled *propinqua* was in cultivation at Kew among a small collection of mutant ferns maintained near one end of the rock garden. This thing had about 80 (actually 82) chromosomes in its roots. I again consulted Alston and was told that *propinqua* was a synonym for var. *abbreviata* (DC.) Newman a taxon which, for some reason unknown to me, Alston at that time believed to be unimportant. However he suggested that I should come with him to a field meeting of the Pteridological Society at Kendal, which I did. I took with me a leaf of my plant and asked for a better identification if anybody present could provide one. The only reply I received to that question was from an old gentleman who told me severely "If I had that thing in my garden I would throw it away". It wasn't abnormal enough. On the other hand when I asked whether any local member could tell me if var. *abbreviata* could be found wild locally I was overwhelmed with kindness and assured that it was plentiful in the Kentmere Valley. To this Alston and I repaired, on our feet if I remember rightly, starting at the nearest bus stop at the bottom end of the valley and walking up the road to beyond the church. There in the cracks of the wall surrounding the church yard we found var. *abbreviata* in abundance and at one glance Alston accepted the idea that this could indeed be a separate species.

Here then for the second time I had stumbled on an unexpected species, chromosomes first. Subsequent investigations have fully confirmed the specific distinctness of *D. abbreviata* (DC.) Newman which is now known from England, Scotland, Wales, Ireland, France, Germany and doubtless other places, on cytologically attested specimens (for further information see Heywood 1964). We also know that *D. abbreviata* is part-parental to *D. filix-mas* and that the hybrid between them is sterile. In this case therefore *D. borreri (paleacea* or *pseudomas)* proved to have been a red herring in the sense that though it shares the same chromosome numbers as those of the *D. filix-mas/abbreviata* complex it is *not* the hybrid between these species but only a more distant relative. This story, as far as it had reached in 1950, will be found in chapter 4 of my book.

Another chapter of the *D. filix-mas* serial will I hope shortly be worked out by Christopher Fraser-Jenkins. You will remember that last year at our meeting at Chelsea Physic Garden (see Newsletter 10: 6) he told us about his recent travels in the Causasus during which he found a new diploid *Dryopteris* possibly representing the hitherto missing other parent of *D. filix-mas.*

If he can prove this, and I very much hope that he can, it will round off in a most wonderful way the conundrum so unceremoniously dumped on me by the medical class in Manchester more than 40 years ago.*

The last thing that I actually did before the second world war broke out was to send a short note to Nature (Manton 1939b) outlining the *D. filix-mas* story as it then stood, in reply to a new paper by Döpp which had appeared in 1938. The outbreak of war makes a convenient and indeed necessary stopping place in this narrative. You will notice that I had not yet written the book, which is dated 1950, and indeed without the war I might never have done so, as explained in the Preface to that volume. I had by slow and laborious stages, spread over 10 years, built up a certain technical facility, applicable to flowering plants and the easier ferns (such as *Osmunda*) and had uncovered some unexpected problems which indirectly had added two species to the recognised flora of Britain. Further technical progress was nevertheless still needed before the more difficult ferns, notably the Polypodiaceae, could be handled with the precision and ease which is now customary. How this took place and what happened on the pteridophyte front before during and after compilation of the book must be explained, if at all, on a later occasion.

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* Since the above was written further details have come to light — see Fraser-Jenkins & Corley (1973)

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TMESIPTERIS IN THE SOLOMON ISLANDS

A.F. BRAITHWAITE*

ABSTRACT

Studies of recently collected material of *Tmesipteris* have revealed a wider range of morphological, anatomical and ecological variation than hitherto known in the genus from the Solomon Islands. Three species, *T. oblanceolata* Copel., *T. tannensis* (Spreng.) Bernh. and a new species, **T. solomonensis** A.F. Braithw., are described. The most interesting is *T. oblanceolata* Copel., an erect partially terrestrial species which closely resembles in many respects the New Caledonian endemic species *T. vieillardii* Dang.

INTRODUCTION

Tmesipteris was first collected in the Solomon Islands by Kajewski in the early nineteen thirties from Tatuve Mountain, Guadalcanal, and subsequently described by Copeland (1936) as *Tmesipteris oblanceolata.* Since Kajewski's original collection no further specimens have been recorded or collected for over thirty years so that our knowledge of this small genus in the Solomon's group of islands has remained incomplete. During the 1965 Royal Society Expedition to the Solomon Islands the genus was rediscovered and several new gatherings were made from Mt Popomanaseu, Guadalcanal, and Kolambangara in the New Georgia Group, where it was found not infrequently in the mossy forest at higher altitudes. Studies of this new material have revealed a wider range of morphological and ecological variation of the genus in the Solomon Islands than hitherto known. Three different forms can be recognised and the ecology, morphology and anatomy of each of these forms will be described in the present paper.

It is well known and accepted that *Tmesipteris* is found in several different forms but there is lack of agreement amongst taxonomists concerning the status of these variants. Some authors have preferred to place them all under one species, *T. tannensis* (Spreng.) Bernh., while others, notably Endlicher (1833, 1839), Dangeard (1891), Sahni (1925), Wakefield (1943) and Barber (1954) have described various forms as different species based mainly on morphological characters combined in some instances (Dangeard, l.c.; Sahni, l.c.) with anatomical characters. Barber (1957) presented cytological and other evidence to support the recognition of six morphologically distinguishable populations from Australia, Tasmania and New Zealand as good reproductively isolated species. Although no direct cytological or genetical evidence is available for the three forms from the Solomon Islands each of them is considered to be distinct enough in its ecology, morphology and anatomy to merit its recognition as a species. A brief summary of the principal characteristics of each species is given in Table 1.

The most interesting is *T. oblanceolata* Copel., an erect partially terrestrial species, which in its external morphology and anatomy closely resembles the New Caledonian endemic species, *T. vieillardii* Dang. The two remaining forms are both epiphytic on tree ferns, one being placed under *T. tannensis*, while the other is described as a new species, *T. solomonensis*, which resembles in some respects *T. lanceolata* Dang. from New Caledonia.

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TABLE 1

Summary of principal characteristics of T. oblanceolata

Species	Coll. No.	Habitat	Length of plant (cm)	Transition region (cm)
T. oblanceolata	RSS4782	terrestrial	20 – 35	8 – 13
	RSS4827	epiphyte on *Dicksonia sciurus*	19 – 21	7 – 9
T. tannensis	RSS4420	epiphyte on *Dicksonia sciurus*	7 – 16	1.5 – 3
	RSS4779	epiphyte on *Dicksonia sciurus*	6 – 14	1 – 3
	RSS4783	epiphyte on *Dicksonia sciurus*	8 – 16	1.5 – 3.5
T. solomonensis	RSS4824	epiphyte on *Cyathea solomonensis*	5 – 10	0.75 – 1.5

* Each entry represents the mean of 100 measurements from different plants.

T. tannensis and T. solomonensis

Anatomy of transition region	Leaves	Mean length of stomata (μm)*	Sporophylls	Mean spore size (μm)*
collenchymatous pith with medullary xylem	radially arranged; 10-15x3-4.5mm; oblanceolate	122 124 126 128	In distal half of leafy shoot only; approx. same length as sterile leaves	80 X 32 83 X 35
collenchymatous pith with medullary xylem	radially arranged; 8-12x2.5-3mm; oblanceolate	119 124 125	In distal half of leafy shoot only; approx. same length as sterile leaves	86 X 36
sclerenchymatous pith without medullary xylem	radially arranged; 9-16x3.5-5.5mm; oblong-elliptic	107 109 110 116	In middle or throughout leafy shoot; same length as sterile leaves	74 X 29 75 X 30
sclerenchymatous pith without medullary xylem	radially arranged; 8-14x3.5-4.5mm; oblong-elliptic	107 111 112 113	Throughout leafy shoot; same length as sterile leaves	–
sclerenchymatous pith without medullary xylem	radially arranged; 10-15x3-5mm; oblong-elliptic	102 108 116 117	Throughout leafy shoot; same length as sterile leaves	–
very small sclerenchymatous pith without medullary xylem	arranged in two lateral rows; 10-16x3-4mm; ovate-lanceolate	90 96 98 99	In proximal half of leafy shoot often only at the base; shorter than sterile leaves	63 X 23 64 X 23

T. OBLANCEOLATA COPEL.

Copeland (1936) distinguished this species by its oblanceolate leaves which are broadest in the distal half with broadly rounded apices and approximately symmetrical in the proximal half. I follow Copeland in recognising this species but the new material at my disposal has made it possible to amplify considerably its distinctive features. In addition to the leaf characters, other features which distinguish this species from the remaining forms of *Tmesipteris* in the Solomon Islands include its partially terrestrial habitat, long transition region and a large collenchymatous pith with medullary xylem in the transition region. The account which follows is based on two gatherings (RSS4782 and RSS4827) from Mt Popomanaseu, Guadalcanal.

Ecology: The few ecological observations available suggest this species is somewhat variable in its habitat. Of the two recent collections, one was terrestrial growing erect out of the moss around the base of a large tree trunk in mossy forest at 1520 metres (Plate XXIX C), while the other was epiphytic and semi-erect on the trunk of the tree fern, *Dicksonia sciurus* C. Chr., at 1155 metres. The type material and only other collection was found by Kajewski growing out of the moss covering stunted trees at an altitude of 1700 metres. It is clear from these records that this species is less closely associated with tree ferns than the other two species in the Solomon Islands, and that it appears to favour a mossy substrate on top of wood or soil.

Habit: The erect terrestrial plants possess long radially symmetrical shoots up to 32 cm high while the epiphytic plants are much shorter reaching only 21 cms. In both cases the basal transition region is much longer than in *T. tannensis* and *T. solomonensis*, representing more than a third of the total length of the shoot, and bears a larger number of small scale-like leaves. The leafy part of the shoot is made up of numerous closely packed sterile leaves and sporophylls (Plate XXIX D). In the living condition the plants are rather dark almost blue-green, particularly the terrestrial material.

Anatomy of the transition region: The most notable feature of the anatomy of *T. oblanceolata* is the presence of a large collenchymatous pith sometimes with medullary xylem in the lower parts of the aerial shoot. Medullary xylem has previously been reported in both the transition region and leafy shoot of *T. vieillardii* from New Caledonia (Sahni 1925), but in the present material it is found only near the base of the transition region. Apart from this difference, the general features of the anatomy of *T. oblanceolata* which are described below are virtually indistinguishable from those described and illustrated by Sahni (1925) for *T. vieillardii.*

In *T. oblanceolata* the solid core of tracheids of the rhizome becomes medullated at the base of the transition region, enlarges and splits into a variable number of groups of tracheids. As the stele expands the groups of tracheids form a ring of mesarch bundles surrounding a clearly defined pith which is made up of thickened slightly collenchymatous cells. Near the base of the transition region the xylem strands sometimes cut off groups of tracheids towards the centre of the shoot axis which then pass through the pith longitudinally for a short distance. One of these medullary strands can be clearly seen in the transverse section in Plate XXX C, cut at *c.* 1cm from the base of the transition region of the terrestrial material. The medullary strands are without protoxylem and apparently end blindly in the pith.

In both the terrestrial and epiphytic material the medullary xylem is small in amount and has so far only been found in the basal 1—2cm of the transition region. Among the terrestrial plants it was found in three of the four specimens which were

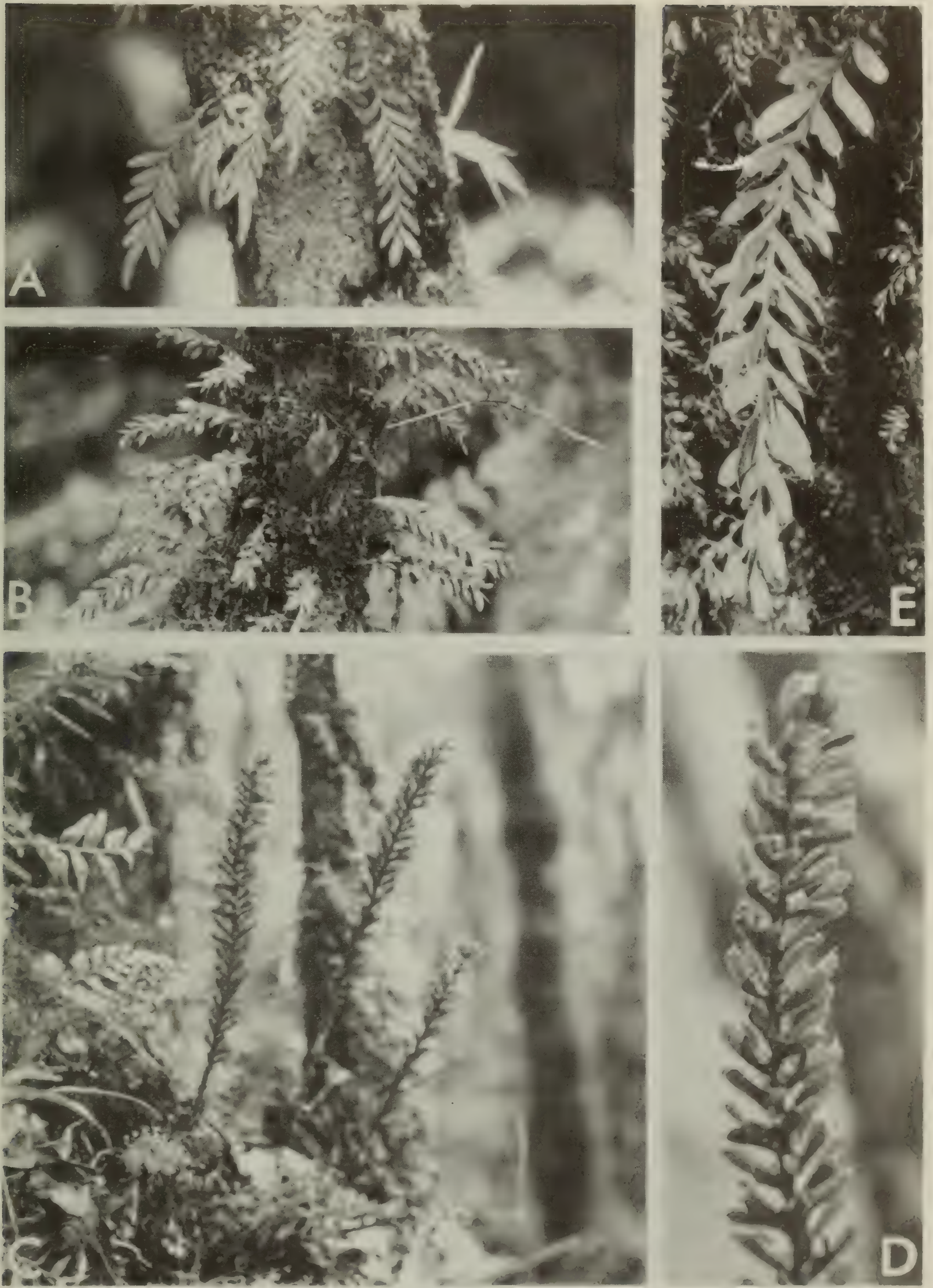


PLATE XXIX. *Tmesipteris* in the Solomon Islands. **A**: *T. solomonensis,* Guadalcanal, RSS4824, epiphytic on the trunk of Cyathea solomonensis; **B**: *T. tannensis,* Mt Popomanaseu, Guadalcanal, RSS4779, epiphytic on the trunk of Dicksonia sciurus; **C & D**: *T. oblanceolata,* Mt Popomanaseu, RSS4782, growing out of moss carpeting the base of a large tree trunk; **E**: *T. tannensis,* Kolambangara, New Georgia Group, RSS4420.

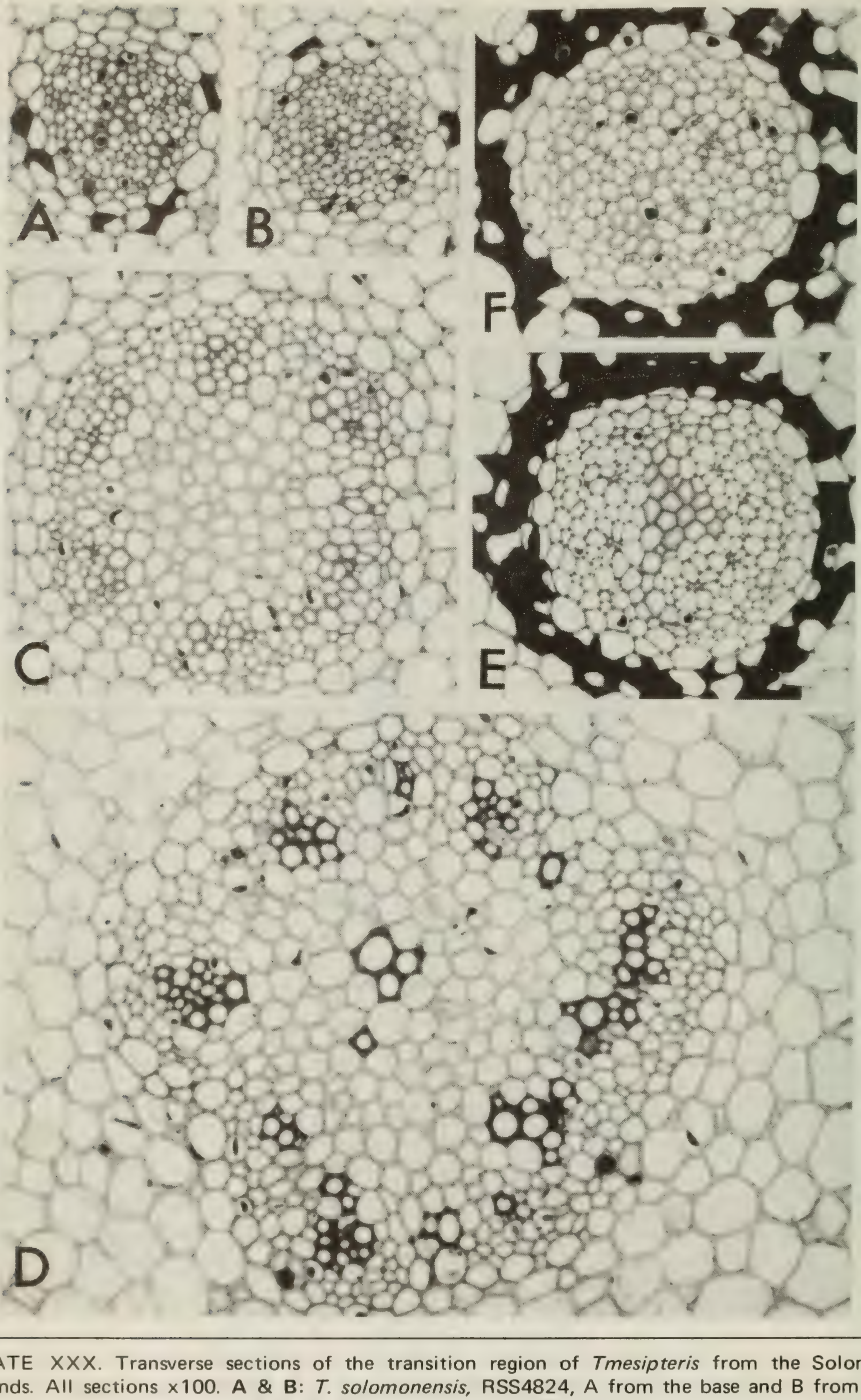


PLATE XXX. Transverse sections of the transition region of *Tmesipteris* from the Solomon Islands. All sections x100. **A & B**: *T. solomonensis,* RSS4824, A from the base and B from the top of the transition region; **C & D**: *T. oblanceolata,* RSS4782, C is from the base and D from the top of the transition region; **E & F**: *T. tannensis,* RSS4420, E is from the base and F from the top of the transition region.

sectioned and among the epiphytic material it was present in the single specimen which was available for sectioning. It has not been found in any material of *T. tannensis* or *T. solomonensis* which has been examined. It is, therefore, concluded that medullary xylem is a reasonably characteristic feature of the basal part of the transition region of *T. oblanceolata.*

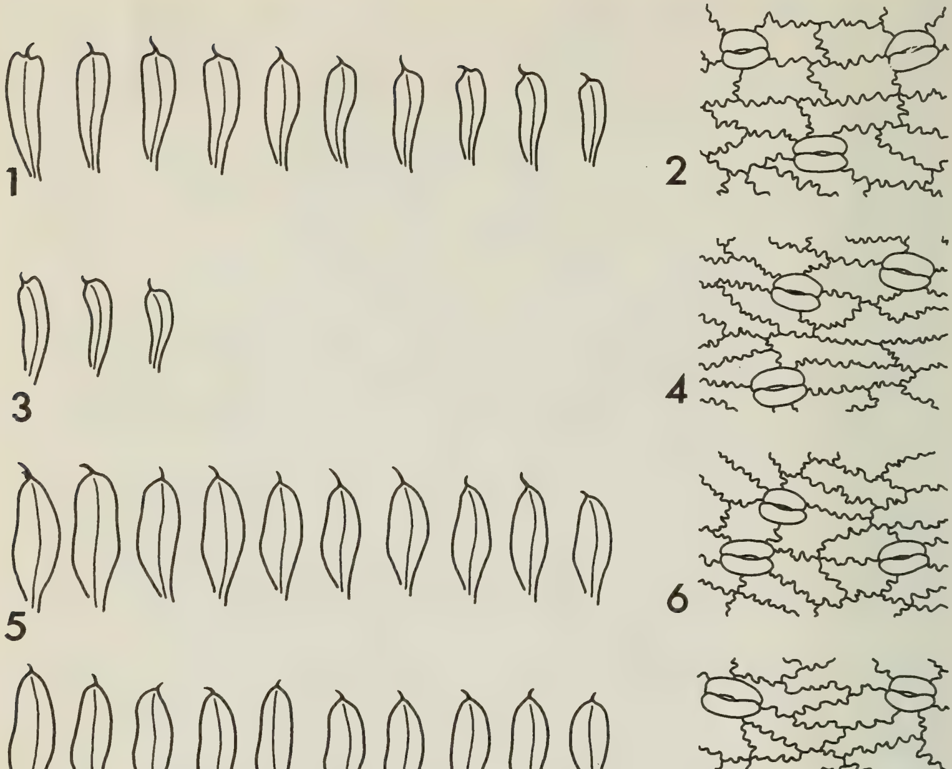
In the upper part of the transition region and the lower part of the leafy shoot the stele is made up of a ring of mesarch bundles, each with internal and external phloem surrounding a relatively large pith which is devoid of medullary xylem. A typical section from the top of the transition region (Plate XXX D) shows a pith, up to 10 cells across, made up of thick-walled collenchymatous cells surrounded by six strands of tracheids. The pith cells are more uniformly thickened and with much thicker cell walls than those near the base of the transition region. (Compare Plate XXX C & D). In longitudinal sections they are long and rather narrow with straight or oblique end walls and with numerous small, round, oval or slit-like pits in the side walls. They are quite different in appearance even in transverse sections from the fibre-like pith cells found in *T. tannensis* and *T. solomonensis.*

It is interesting to note that the dark material, usually referred to as phlobaphene or tannin anhydrides, which is commonly deposited in the cortical cells surrounding the stele in the rhizome and aerial shoots of *T. tannensis* and *T. solomonensis* is absent from the present material, except in the rhizome and immediately adjoining portion of the transition region.

Leaves and Sporophylls: The oblanceolate leaves are broadest in the distal half with broadly rounded mucronate apices and taper gradually towards the base (Figs 1 and 3). They are easily distinguished from the leaves of *T. tannensis* and *T. solomonensis* which, in contrast, are broadest about the middle and proximal halves of the leaves respectively. The epidermal cells and stomata (Figs 2 and 4) show no useful distinguishing features although the guard cells of the stomata tend to be longer than in either of the two other Solomons taxa (see Table 1).

The sporophylls tend to be confined to the upper part of the leafy shoot and are approximately the same length as the sterile leaves. The spores are the largest found amongst the material from the Solomon Islands (see Table 1). In the two spore samples available from the terrestrial material there is a small proportion of mis-shapen and apparently abortive spores. Abnormal spores have previously been reported by Sahni (1925) in spore samples from *T. vieillardii.* The significance of these observations is not at present clear but they perhaps indicate some cytological irregularity at meiosis in these plants. Unfortunately no cytological observations are available for the material.

Discussion: The material treated here as *T. oblanceolata* resembles closely the endemic terrestrial species, *T. vieillardii*, from New Caledonia. Both species share an erect terrestrial habit, a long transition region with numerous small scale leaves and a leafy shoot (dark green in colour) with many closely set leaves and sporophylls confined to the distal half. In addition the two species are anatomically virtually indistinguishable, both possessing a relatively large collenchymatous pith with medullary xylem in the transition region. The leaves of *T. vieillardii* are, however, narrow and strap-shaped with parallel sides and are always strongly falcate and recurved.



FIGURES 1—12. Leaves and epidermis of *Tmesipteris* from the Solomon Islands. Each leaf represents a different plant. 1—4: *T. oblanceolata,* 1 & 2 = RSS4782, 3 & 4 = RSS4827; 5—10: *T. tannensis,* 5 & 6 = RSS4420, 7 & 8 = RSS4779, 9 & 10 = RSS4783; 11 & 12: *T. solomonensis,* RSS4824. Leaves natural size.

T. TANNENSIS (SPR.) BERNH.

Tmesipteris tannensis is based on *Lycopodium tannense* Sprengel (1800, page 267) and it is doubtful whether any type specimen exists. It is therefore not certain that the Solomon Islands material to be described here is the same species. No Forster specimen from Tanna has been seen and the plant illustrated by Bernhardi (1801) possesses pointed synangia, a feature not present in the Solomons material. Despite this difference it is considered preferable to place this material here until the precise nature of the type material has been clarified in order to avoid describing a new species which in the final analysis may prove unnecessary.

T. tannensis is distinguished from *T. oblanceolata* by being always epiphytic on tree ferns and by its aerial shoots with a shorter transition region, less densely arranged oblong-elliptic leaves and smaller spores as well as by a number of anatomical features. The following observations are based on two gatherings from Mt Popomanaseu Guadalcanal (RSS4779, RSS4783) and one from Kolambangara, New Georgia Group (RSS4420, Plate XXIX E).

Ecology: T. tannensis is the commonest form of *Tmesipteris* in the Solomon Islands. It was found quite frequently on the trunks of *Dicksonia sciurus*, which is a common tree fern in the higher altitudes of the montane forest from 1200–2286 metres (Plate XXIX B). It is apparently confined to this species of tree fern in the Solomon Islands since extensive searching did not yield any specimens from *Cyathea* species even though these were often present in the same locality.

The specificity of any particular form of *Tmesipteris* for a tree fern species or group of species has never been recorded but it is noteworthy that a collection of almost identical material from Goodenough Island, New Guinea (Brass 24749,K) bears a collector's note indicating that it was only found on *Dicksonia* (species not specified) and never on *Cyathea* species which were present in the same locality.

Habit: The pendulous aerial shoots are shorter than those of *T. oblanceolata* with a short transition region representing only a fifth or sixth of the total length of the shoot. The leaves and sporophylls are radially arranged, as in *T. oblanceolata*, although there are sometimes a few sterile leaves at the apex of the shoot arranged in two rows. They are, however, much less densely arranged and consequently fewer in number than in the previous species.

Anatomy of the transition region: So far as the anatomy of the aerial shoot is concerned the main differences from *T. oblanceolata* lie in the sclerenchymatous nature and pitting of the pith cells and in the absence of medullary xylem from the pith in the transition region. Some of the principal features of the anatomy are illustrated in Plate XXX E & F, which show transverse sections from the lower and upper parts of the transition region respectively.

At the base of the transition region the solid core of tracheids of the rhizome expands and divides to form two or three mesarch bundles. Meanwhile groups of thickened, lignified fibre-like cells appear at the periphery of the stele (Plate XXX E). Moving upwards through the transition region the groups of tracheids gradually increase in size and divide further to form a ring of bundles and sclerenchymatous cells appear in the centre forming a pith. These pith cells are at first joined laterally to the fibre-like cells at the periphery of the stele but towards the top of the transition region the peripheral fibre-like cells disappear altogether so that a typical section from the top of the transition region shows a ring of five to seven mesarch bundles surrounding a well defined pith made up of 15–20 sclerenchymatous cells (Plate XXX F). Each bundle is made up of a group of thin walled tracheids with lignified phloem cells on either side. The pith cells are narrow and fibre-like with numerous slit-like pits in the side walls and even in transverse sections are quite different in appearance from the collenchymatous pith cells of *T. oblanceolata.* No medullary xylem has been observed in the pith of the transition region. Phlobaphene is present in the inner cortical cells throughout the transition region and lower part of the leafy shoot.

Leaves and Sporophylls: The sterile leaves are somewhat unequal-sided at the base, oblong-elliptic, with a mucronate apex (Figs 5, 7, and 9). They are broadest in the middle of the leaf and are quite different in shape from those of *T. oblanceolata*, which are broadest towards the apex. The epidermal cells and stomata are shown in Figs 6, 8 and 10 and size of the guard cells of the stomata in Table 1. The guard cells are smaller than those of *T. oblanceolata* but otherwise the epidermal characters do not show any major distinguishing features.

The sporophylls are found in the middle or throughout the length of the aerial shoot and, as in *T. oblanceolata*, are approximately the same length as the sterile leaves. The synangia are rounded and the spores are smaller than those of *T. oblanceolata* (see Table 1).

Discussion: The morphology and anatomy of the Solomons plants matches very closely that of the material referred to *T. tannensis* var. *tannensis* by Sahni (1925) from New Caledonia. They are also virtually indistinguishable in their external morphology from a *Tmesipteris* collection seen from Goodenough Island, New Guinea, (Brass 24749, K).

A NEW SPECIES FROM GUADALCANAL

T. solomonensis A.F. Braithw. sp. nov. Planta epiphytica, 5–10 cm longa; pars transitionis 7.5–15 mm longis, 4–10 bracteis foliiformibus. Folia sterilia, bifaria praeter basem, herbacea 10–16 mm longa, 3–4 mm lata, ovato-lanceolata, apice truncato-mucronatis. Sporophyllae plerumque versum basem caulis foliosi, radialiter dispositae, foliis sterilibus breviores. Capsulae 2.5 x 1 mm, sphaericae; sporis 56 – 71 μm longis, 19 – 26 μm latis (ordo mediis 64 x 23 μm). (Plate XXIX A).

TYPE: Central Guadalcanal: Mt Popomanaseu, by path from Vunuvelakama to Tambulusu; epiphytic on *Cyathea solomonensis* Holttum in ridge-top forest; 1066m. Braithwaite RSS4824, 6 Nov. 1965. *Holotype, BM*; isotype K

Habit: The small pendulous plants possess light green rather delicate aerial shoots up to 10 cm long with a short transition region representing a sixth or seventh part of the whole shoot. In contrast to the two previous species almost all the sterile leaves are arranged in two lateral rows except for one or two near the base of the leafy part of the shoot which are often arranged radially. The radially arranged sporophylls occur between the base and middle of the leafy shoot.

Anatomy: The anatomy of the transition region of *T. solomonensis* is similar to that of *T. tannensis* and need not be described in detail here. Transverse sections from the lower and upper parts of the transition region are shown in Plate XXX A & B for comparison with the two previous species. It will be noted that the stele is very small and that the pith even at the top of the transition region is rather ill-defined and consists of only a few sclerenchymatous cells. In longitudinal sections the pith cells are fibre-like with narrow slit-like pits. Surrounding the pith there are 3 or 4 mesarch bundles made up of thin walled tracheids with lignified phloem cells on either side. As in *T. tannensis* the cortical cells around the stele contain phlobaphene.

Leaves and Sporophylls: The sterile leaves are ovate-lanceolate with a mucronate somewhat truncate apex (Fig 11). They differ from the leaves of *T. oblanceolata* and *T. tannensis* by being broadest towards the base of the leaf and by their softer more herbaceous texture. The epidermal cells and stomata (Fig 12; Table 1) are smaller than in the previous two species.

The sporophylls tend to be confined to the base of the leafy part of the shoot and are generally rather shorter than the neighbouring sterile leaves. The synangia are rounded and the spores are the smallest found amongst the material from the Solomon Islands (see Table 1).

Discussion: This new species is distinguished chiefly by its ovate-lanceolate leaves which are arranged in two lateral series, its sporophylls which are shorter than the neighbouring leaves and found only towards the base of the aerial shoot and by its small spores. It resembles *T. lanceolata* Dang. of New Caledonia in its biseriate arrangement of the leaves, anatomy and sporophylls, which are towards the base of the leafy shoot and shorter than the neighbouring sterile leaves. In addition a spore illustrated by Sahni (1925) from the New Caledonian material matches in size almost exactly spores measured from *T. solomonensis.* It is however, not the same species. The New Caledonian species is a larger and more robust plant with thicker leaves which are broadly lanceolate or ovate and taper gradually to a point.

ACKNOWLEDGEMENTS

The author wishes to express sincere gratitude to the Royal Society of London for the opportunity to visit the Solomon Islands and gratefully acknowledges the photographic assistance of Mr B.V. Case while preparing the illustrations.

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REVIEWS

FERNS TO KNOW AND GROW by F. Gordon Foster, 23.5 X 18 cms; 258 pages, 34 photographs (16 colour), 84 pages of line-drawings; New York: Hawthorn Books and Scarborough, Ontario: Prentice-Hall, 1971; price $7.95.

This is a revised and enlarged edition of The Gardener's Fern Book originally published in 1964 by Van Nostrand and reviewed in Brit. Fern Gaz. 9:204 and J. Roy. Hort. Soc. 92:44. Here is an even better book by this well-known fern-lover, photographer, microscopist and member of several specialist societies including the British Pteridological Society. The twelve chapters include an introduction to the biology of ferns, to their identification, and their culture and propagation in various habitats. I had hoped my objection for page 60 might have been agreed and corrected, that it is unwise to store spores in a sealed bottle, because they may sweat and mould; instead, leave them on the paper and fold this to form a spore-tight envelope.

Two-thirds of the book presents an enumeration of 67 selected ferns (40 for the garden and 27 for the house) giving descriptions, culture, and illustrations which include diagnostic enlargements. Several native British ferns and several fancy varieties are included.

This excellent book should be on every fern-lover's bookshelf.

J.A. CRABBE

THE BRISTOL FLORA by J.W. White; 722 pp., 1 colour folding map. 145 X 222 mm. 1912 facsimile reprint, 1972, Chatford House Press. £6.25.

This is a book which is expensive and at first glance of restricted use. The first 109 pp. analyse the flora, with very informative historical work. For those who collect County Floras, White's numerous comments on the ecology and taxonomy of the plants make this book a classic and a must, although for the fern enthusiast who shies other plants (if there be such people) this is expensive for 19 pp. on ferns.

A.C. JERMY.

AZOLLA AND ITS OCCURRENCE IN VIRGINIA *

FRANKLYN D. OTT** & ALETA JO PETRIK-OTT**

ABSTRACT

A review of the species of *Azolla* found in the United States is presented and their geographical distribution within the United States discussed. It is suggested that *Azolla* populations in the northern states are natural and indigenous, not introductions by man or aquatic birds. Records for the occurrence of *Azolla* in the Middle Atlantic States bordering Virginia are reviewed. Thirteen previously unreported collections of *A. caroliniana* are given for the Tidewater area of Virginia and a written description of this species from this locality is presented.

INTRODUCTION

The heterosporous pteridophyte genus, *Azolla*, having the type species *Azolla filiculoides* was created by de Lamarck in 1783 to accommodate a plant collected by Commerson somewhere in the Magellan area of South America during his voyage around the world (1767–1769). Contemporary authorities, e.g. Svenson (1944), now consider that the genus may contain six or seven good species. Among these, *A. filiculoides* de Lamarck, *A. caroliniana* Willdenow and *A. mexicana* Presl are recognized in the flora of the United States. Whether or not *A. mexicana* is synonymous with *A. caroliniana* cannot be treated within the scope of this paper. Certainly, on one hand, Svenson (1944) presented good evidence based upon both vegetative and reproductive characteristics that these are two distinct species. On the other hand, Godfrey, Reinert & Houk (1961) have rightfully questioned the use of septate vs. non-septate glochidia as distinguishing specific characteristics for *Azolla.* Since this is a key character in differentiating *A. caroliniana* from *A. mexicana*, its utilization therein should be carefully employed.

We have collected *Azolla* from 13 sites in Virginia. All the material collected to date has been sterile but on vegetative characters, these collections have been identified as *A. caroliniana.*

SPECIFIC DISTRIBUTION IN THE UNITED STATES

In the United States *A. filiculoides* is limited in its distribution to the states bordering the Pacific, e.g. California (Underwood 1890), Oregon (Peck 1941), Washington (Frye 1934), Alaska (Svenson 1944), with occasional records further inland, e.g. Arizona (Kearney and Peebles 1951).

Depending upon the viewpoint, if *A. mexicana* is recognized as a distinct species, its distribution in the United States is northward from New Mexico (Dittmer, Castetter & Clark 1954) and California (Mason 1957) to Washington, Utah, Nevada (Svenson 1944), Wisconsin (Tryon et. al. 1953), and Minnesota (Tryon 1954). It extends to the Mississippi with occasional reports further eastward, e.g. Illinois (Fore, Stookey & Parsons 1965; Mohlenbrock 1967). Interestingly, however, material from Texas has been consistently referred to as *A. caroliniana* (Reverchon 1903; Correl 1949, 1956). Svenson (1944) leaves the general impression that specimens west of the Mississippi cited as *A. caroliniana* would probably be best placed in *A. mexicana.* This species is also known from British Columbia (Taylor 1956).

A. caroliniana is widely distributed over eastern and southern states (Fernald, 1950; Britton & Brown 1936). When found in New York and the New England states,

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its presence is usually attributed to an introduction by man. This is particularly true for the Massachusetts records (Knowlton, Ripley & Weatherby 1921; Goodaie 1932; Smith et al. 1933). Though this is undoubtedly the case in some incidences, e.g. in New York per the reports of Knight (1885) and of Henshaw (1886), this explanation is probably insufficient for most of these more northern states.

In this regard, it should be emphasized that precise contemporary information on the continuous occurrence of *Azolla* in these northern states is not available. It is entirely plausible, on one hand, that the plant is continuously being re-introduced into these areas annually, or from time to time, via the migrations of aquatic birds (Ridley 1930). On the other hand, it appears to us that it is even more plausible to consider *Azolla* a permanent member of the flora of these states. This is particularly tenable if one considers the duration of time between the initial reports of *A. caroliniana* in Lake Ontario (Torrey 1843) and its occurrence there 60 years later (Gilbert 1903). Records by Peck (1870) of *A. caroliniana* in Black Creek near Oneida Lake were confirmed some thirty years later by the collections of Maxon (1900) from evidently the same site. *A. caroliniana* was reported from the Canadian side of Lake Ontario (Macoun 1890) 30 years after its initial report there (Hooker 1860). We have collected *A. caroliniana* in the Dismal River, just south of Thedford, Nebraska [Aleta J. Ott No. 781 (KANU)], 75 years after it was initially found there [P.A. Rydberg No. 1728 of August 24, 1893 (NEB)]. It has been collected in that vicinity by a number of workers throughout the years: H.J. Webber No. 6101 of July 21, 1899 (NEB); Peterson (1935); Kierner No. 20666a of May 27, 1946 (MO). Certainly, the winters of Nebraska may be correctly described as harsh. The long duration of time between these collections from the same area is indicative that the *Azolla* populations can maintain themselves under the harsh winter conditions of the area. A close analysis of the Minnesota and Wisconsin populations would probably support this opinion.

AZOLLA IN THE CENTRAL ATLANTIC STATES BORDERING VIRGINIA

In the central Atlantic states bordering Virginia, *A. caroliniana* has been reported in Maryland by Reed (1951, 1953) in "several localities in the limestone drainage in south-central Frederick County, around Buckeystown".

The Gray Herbarium contains two representative collections from the District of Columbia: Pond in Kenilworth Aquatic Garden, N.E., Leg. F.J. Hermann No. 11659 of Dec. 6, 1950, (GH) and Pool along Piney Creek near 16th Street Leg. L. Kelso No. 6463b of May 4, 1950, (GH).

For North Carolina, Blomquist (1934) reports the species from two counties: Currituck County at Kitty Hawk, and New Hanover County near Wilmington. The more recent publication on the vascular flora of North Carolina by Radford, Ahles, and Bell (1968, map) reports its presence in eleven counties in North Carolina; no details pertaining to the representative collections are given. We have collected *A. caroliniana* in Camden County 0.3 miles southwest of the city limits of South Mills, N.C., just across the Virginia-North Carolina border (Aleta J. Ott No. 859).

In Tennessee *A. caroliniana* is abundant in the western areas of the state. However, it is also known from the eastern counties of Bradley and McMinn (Gattinger 1901; Shaver 1954). There appear to be no records from West Virginia, though the species is known from Ohio (Hopkins 1907).

AZOLLA IN VIRGINIA

On 10 October 1970, we collected abundant material of *A. caroliniana* from a marshy area on Jamestown Island, James City County, Virginia. A preliminary search of the literature revealed no reports of this plant for the state. Shortly after this, Dr Henry K. Svenson sent us some pressed herbarium material of the same species bearing microsporangia which he had collected from the Chickahominy in New Kent County. A further literature search turned up a record in the unpublished Master's Thesis of Loetterle (1970) and a note of its occurrence at Svenson's Chickahominy site by Harvill (1967). In the following year we collected this plant in 12 additional sites in the Tidewater area of Virginia.

These finds confirm the prediction of Massey (1944) that *A. caroliniana* should be found in the Coastal Plain of Virginia. Because of the abundance of this plant in the southern Tidewater area, we are surprised that it has been overlooked for so long. This in all probability can be attributed, in the main, to the lack of extensive collecting in this area, especially during the late summer and autumn months at the height of the *Azolla* development. The *Azolla* populations are meager during the late winter and are not to be found in abundance again until late summer.

The name of *A. caroliniana* was established by Willdenow (Sp. Pl. 5: 541; 1810) to accommodate plants received from Richardson in Paris which had probably been collected by Michaux (Svenson 1944). Willdenow gave only the following as to where the material had been collected: "Habitat in aquis *Carolinae*." The description which follows is based on *A. caroliniana* from Virginia:

Plants aquatic, small, reaching 30mm in diameter (frequently larger in undisturbed situations), superficially resembling duckweeds or mosses, triangular ovate to ovate-oblong, horizontally flattened, bright green to purplish-red, floating or occasionally stranded, frequently forming considerable masses; lamina pinnately branched in one plane; axis inconspicuous due to the crowded, imbricate pinnae; pinnae alternate, divided into a dorsal and ventral lobe; dorsal lobe ovate to nearly orbicular, up to 0.8mm long and 0.6mm wide, chlorophyllous, with a hyaline margin, surface minutely papillose, several cells thick, containing cavities in which occur filaments of the blue-green alga, *Anabaena azollae* Strasburger, not reaching the water, flattened to somewhat erect with age; ventral lobe generally achlorophyllous, appearing colorless or sometimes reddish, distal half one cell thick, proximal half more than one cell thick, in contact with the water only on its lower surface, ovate to nearly orbicular, somewhat larger than the dorsal lobe; roots borne on the central axis, slender, unbranched, root and root hairs partially covered by a sheathing root cap which falls off with age; sporocarps rarely observed, borne in pairs in older leaf axes, their wall a modified indusium; megasporangia rarely reported; microsporangia globose, with 8–40 microsporangia in an indusium (Svenson 1944), each microsporangium containing 32–64 (embedded) microspores aggregated into 3–4 massulae: massulae bearing barb-tipped, non-septate (Svenson 1944; Godfrey, Reinert & Houk 1961) and septate (Godfrey, Reinert & Houk 1961) glochidia; chromosome number reported to be 2n = 48 (Litardière, 1921).

REPRESENTATIVE SPECIMENS

Herbarium material of each of the following collections have been deposited with the curators of the following herbaria: College of William and Mary, Williamsburg, Virginia, U.S.A.; Smithsonian Institution, Washington, D.C., U.S.A.; and the British Museum (Natural History), London, England.

All the following material was collected by the authors from Virginia: the collecting number (in italics) refers to the field book of Aleta J. Ott.

CHARLES CITY CO.: swampy area, 1.3 mi S Providence Forge on Prim. Rt. 155, 0.4 mi from county line between New Kent Co. and Charles City Co., 27 Oct. 1971, *855*. CITY OF CHESAPEAKE (formerly Norfolk Co.): small pond, 0.2 mi E of intersection of Fentress Air Field Road and Blackwater Road, 30 Oct. 1971, *858*. CITY OF VIRGINIA BEACH (formerly Princess Anne Co.): Tabernacle Creek at Sandridge Road, Va., 30 Oct. 1971, *860;* marshy area of median strip of Nat. Highway 60, edge of Seaside State Park, 1.7 mi NW junction of Rt. 60 with Rt. 305, 30 Oct. 1971, *861*. GLOUCESTER CO.: abundant along edges of Haynes Mill Pond, N of Sec. Rt. 614, 18 Oct. 1970, *828;* Leigh's Pond, ca. 0.5 mi NW Rt. 616 and ca. 0.75 mi N Clay Bank, Va., 22 Jan. 1972, *875*. JAMES CITY CO.: marshy area behind Cooper sign, return trip on short loop on Jamestown Island, 10 Oct. 1970, *847*. KING WILLIAM CO.: first small pond on golf course, West Point, Va., SW of Prim. Rt. 30, 1.5 mi S junction with Sec. Rt. 635, 13 Nov. 1971, *869;* pond beside Highway 14, 0.5 mi E of junction with Sec. Rt. 610, 9 Jan. 1972, *873*. NEW KENT CO.: Chickahominy River, marshy areas, end of Sec. Rt. 627 near Lanexa, Va., 27 Oct. 1971, *854*. SURRY CO.: junction of Sunken Marsh Creek and Sec. Rt. 626 near Claremont, Va., 7 Nov. 1971, *865*. YORK CO.: Bracken's Pond, ca. 2 mi NW Yorktown, Colonial National Monument Parkway, 8 Nov. 1971, *866;* upper end of West Branch, Colonial National Historical Park, 8 Nov. 1971, *867*.

ACKNOWLEDGEMENTS

We wish to acknowledge with genuine pleasure the use of the library facilities of the Farlow Reference Library of Cryptogamic Botany, Harvard University, Cambridge, Massachusetts, and of the Missouri Botanical Garden, Saint Louis, Missouri. We are appreciative to Prof Dr P. Bourrelly, Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie, Paris, who so kindly sent us photocopies of the herbarium labels of the type material of *A. filiculoides*.

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REVIEW

MORPHOLOGY OF VASCULAR PLANTS by David W. Bierhorst: XII = 560 pp. 180 X 260 mm. 1971, Collier-Macmillan. Price £7.50.

Dr Bierhorst says in his preface that this book has been written to satisfy a particular need, namely a book in sufficient detail and depth to serve as both a text and a reference. For the most part he has achieved this. The title is rather misleading and one looking for detailed information on the Angiospermae (Angiospermopsida) may not find it in the 40 pages allocated to them. The pteriodphytes on the other hand come off very well with 368 pp. given over to them: fossil species are also covered.

One of the interesting important features of the book is the classification adopted. Bierhorst compares this with Copeland (1947), Engler and Diels (1936) and Pichi-Sermolli (1958) and two striking aspects are the withdrawing of Ophioglossales and Marattiales from the Filicopsida and giving them class-status of their own in a position which suggests them to be more advanced than the rest of the Filicopsida (a fact incidentally supported by at least their flavonoid chemistry; (Swain, pers. comm.). Some would have gone further, maybe, and taken out also Osmundales. Bierhorst's other point here is more generally known (but still actively challenged): ie the Psilotaceae being in the Filicopsida near *Stromatopteris* and the *Gleichenia.*

The amount of detail given for each group varies with Dr Bierhorst's experience and although he has looked at most things first-hand some have taken a back seat. In Isoetaceae I would have liked to see something about the terrestrial species (*I. histrix* group). There is little mention about the habitats in which *Isoetes* lives and the data given is therefore not related to the environment. Stomata for instance are not mentioned at all. On the other hand in the Lycopods, a group Bierhorst knows well, the text is packed with general biological and field observations which stimulate me to look for the subterranean gametophyte of British species.

The book is very nicely produced with a clear type face and numerous photographs (mostly taken by the author). There is a full bibliography. In a book so full of facts there are bound to be some that are incorrect or misleading. I would have hoped to see an up to date nomenclature and the use of synonyms in legends of figures (eg *Equisetum maximum* Fig. 7—IIA) is unfortunate. All pteridologists may find in this book something to criticise but we have to thank David Bierhorst for a stimulating book that makes us want to look at material — and other species — for ourselves.

A.C. JERMY.

ABNORMALITIES IN OPHIOGLOSSUM

H.K. GOSWAMI* and SHARDA KHANDELWAL*

INTRODUCTION

Chrysler (1925), discussing the "pinna nature" of the fertile spike of Ophioglossaceae, considered the occurrence of sporangia on the sterile fronds of *Botrychium* and *Helminthostachys* to be of evolutionary significance. This phenomenon is recorded here for the first time in *Ophioglossum,* whilst spore statistics reveal that this and other anomalies are associated with the sterilization of spores.

MATERIAL AND METHODS

Plants of *Ophioglossum costatum* R. Br., *O. nudicaule.* L. and O. *gramineum* Willd. var. *gramineum* Hook. were collected from Narsinghgarh, and O. *gramineum* var. *majus* Wief. from Shivpuri, Madhya Pradesh during 1967–71.

Young spikes and sporangia were fixed in Carnoy's fixative, and temporary squash preparations for detecting anucleate and mis-shapen spores were stained with aceto-orcein.

OBSERVATIONS

The abnormalities recorded are concerned with three structures: 1: Spike; 2: Sporangia; and 3: Spores.

Spike Abnormalities

Two kinds of spike abnormalities have been found.

a. Bifurcated spikes. Bower (1926) showed forked spikes in *O. pendulum* L. and *O. palmatum* L., and Mahabale (1962) published a photograph of a similar situation in *O. pedunculosum* sensu Prantl., non Desv. (= *O. petiolatum* Hook.; Panigrahi & Dixit, 1969). Present collections show bifurcated spikes in *O. costatum, O. nudicaule* (Fig. 1) and *O. gramineum.* The transverse section of a specimen shows partitioning of the sporangia by a definite wall. Spores from these specimens proved normal.

b. Twisted spikes. Some of the *O. costatum* plants showed twisted spikes. Examination of spores from the middle twisted region showed that as many as 11% were anucleate. Such a high frequency of anucleate spores was not recorded in normal spikes.

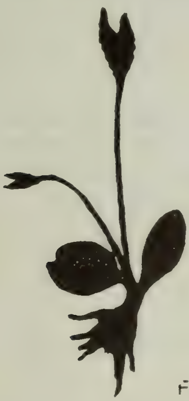

FIGURE 1: Silhouette of plant of *O. nudicaule* showing forked spike (X2).

Sporangial abnormalities

a. Sterile sporangia. Sterile sporangia may occur on the normal spike (Fig. 2).

b. Sporangia on tropophyll. This condition is well documented by Bower (1926) in *Botrychium* and *Helminthostachys.* The present study now reports this condition in *Ophioglossum nudicaule* (Fig. 3).

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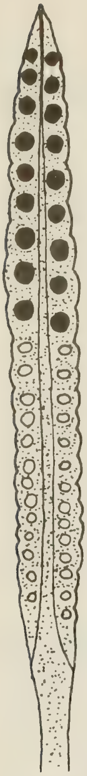

Fig. 3

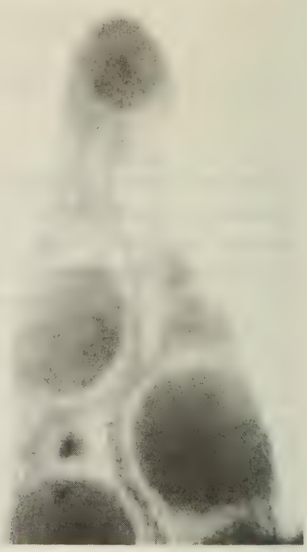

Fig. 4

FIGURE 2: A spike of *O. costatum* showing sterile sporangia in the lower half (X4).

FIGURE 3: Sterile frond of *O. nudicaule* showing sporangia on the margins (X10).

FIGURE 4: A portion of spike of *O. costatum* showing sporangium at the tip of the spike (X16). Note a small globular mass of sporogenous tissue in the same socket.

Fig. 2

c. Apical sporangia. In *Ophioglossum* the large sunken sporangia are fused laterally to form a dense series either side of the midrib. The series usually stops short of the apex of the spike (Bower, 1926). In *O. costatum* exceptions for both these features have been recorded. (Fig. 4).

Spore Abnormalities

The frequency of these observations with their spore analyses are shown in Tables I and II. The following categories have been recognised:

a. mis-shapen spores (probably abortive);

b. anucleate spores.

Numerous spores of the latter type were seen in twisted spikes of *O. costatum* examined. Less frequently they have also been seen in other species of *Ophioglossum, Botrychium ternatum* (Thunb.) Sw. and *Helminthostachys zeylanica* (L.) Hook.

TABLE 1 : FEATURES OF SPORANGIA IN THREE SPECIES OF *OPHIOGLOSSUM*

	O. costatum	O. nudicaule	O. gramineum	
			var. gramineum	var majus
1 No. of plants studied	138	82	24	2
2 Total no. of spikes	74	66	20	2
3 Forked spikes	8	4	7	–
4 Twisted spikes	17	–	–	–
5 No. of sporangia/spike	12–67	5–21	10–34	20–43
6 Plants showing sporangia on tropophyll	2	2	–	–
7 No. of sterile sporangia on:				
(a) spike	10	–	–	–
(b) tropophyll	–	2	–	–
8 Sporangium at the tip of the spike	1	–	–	–
9 More than one sporangium in a socket	9 spikes	1 spike	–	1 spike

TABLE 2 : SPORE ANALYSIS OF ABNORMAL SPECIMENS OF *OPHIOGLOSSUM*

Abnormality	Number of abortive or anucleate spores	Diameter of spores in μm (with mean)	Remarks
I Sporangium at the tip of the spike *(O. costatum)*	20/285	27–33.4 (29.6)	Spores smaller than normal; a few are very small
II Sterile sporangia on otherwise normal spike *(O. costatum)*	–	No spores	Spores from sporangia of the upper half of the spike are quite normal
III Sporangia on tropophyll *(O. nudicaule)*	5/197	21–34 (23.0)	Spores irregular and smaller than normal
IV Twisted spike *(O. costatum)*	40/346	30–37 (32.5)	Anucleate spores are small with ill-developed tri-radiate mark

TABLE 3 : VARIATION IN SIZES OF SPORES

Source	Expected Mean*	Observed mean	χ^2	P
1 Twisted spike	35.9	32.5	0.32	>.50
2 Sporangium at the tip of the spike	35.9	29.6	1.11	>·30
3 Sporangium on tropophyll	34.9	23.0	4.05	>·025

* Based on 50 counts from normal spike

DISCUSSION

The occurrence of sporangia on the margin of the tropophyll of *Ophioglossum nudicaule* gives support to the pinna nature interpretation of the spike. Bower (1935) considered such specimens in *Botrychium* as reminiscent of the half sterile pinna of *Osmunda regalis.*

Sporangial abnormalities appear to be associated with the presence of non-viable spores (anucleate or deformed). Table 3 shows the size of spores from the sporangia of the tropophyll to be significantly smaller than normal (χ^2 = 5.05; p .025), although normal spores were observed from the sporangium at the tip of the spike. Because as many as 11% of the spores present in the middle (twisted) portion of the spike appear to be anucleate, it seems possible that they may be the result of a genetic mechanism leading to sterility.

ACKKOWLEDGEMENTS

We are grateful to Mr B.S. Arya, Department of Botany, Narsinghgarh, M.P. for placing some of his collections at our disposal. Thanks are also due to A.C. Jermy and C.N. Page for suggestions and Prof. T.N. Raghvachar for facilities.

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OBSERVATIONS ON THE PTERIDOPHYTES OF SÃO MIGUEL, AÇORES

O. WILMANNS* and H. RASBACH**

INTRODUCTION

In April 1972, accompanied by R. Gumprecht and K. Rasbach, the authors spent three weeks on São Miguel, the largest azorean island, to become acquainted with the pteridophytes of the extreme atlantic western oceanic part of Europe. It is easy to learn by the census of R. Telles Palhinha (1943, 1966) and the Flora of J. De Carvalho e Vasconcellos (1968), which species can be expected in general. Dansereau (1961) gives the type of distribution of the species but there is a large gap in our knowledge concerning their habitats, communities, local distribution; such ecological, sociological and chorological information is mostly not very precise or totally lacking. This deficiency in knowledge may have been the motive for Ward (1970) and Benl (1971) to publish their observations on the macaronesian islands of Flores and Madeira respectively. In a similar manner we are presenting our material of São Miguel.

The following maps were used: Arquipélago dos Açores, Grupo oriental; 1: 200,000. Instituto Geográfico e Cadastral. São Miguel. 1969. Carta geológica de Portugal; Folha S. Miguel; 1: 50,000 Lisboa. 1958, 1959.

GEOGRAPHICAL FACTS

São Miguel with its 727 km^2, 170,000 inhabitants and the capital Ponta Delgada is not only the largest azorean island and the cultural centre, it is also the most diversified. Its form is like a dumb-bell, the shore line very long being 138 km. The highest elevations are the Pico da Vara (1105 m) in the east, the Pico de Barrosa (949 m) in the middle, and the Pico das Eguas (856 m) in the west. The island was built up by purely volcanic material during the Upper Tertiary; underground there are basaltic,

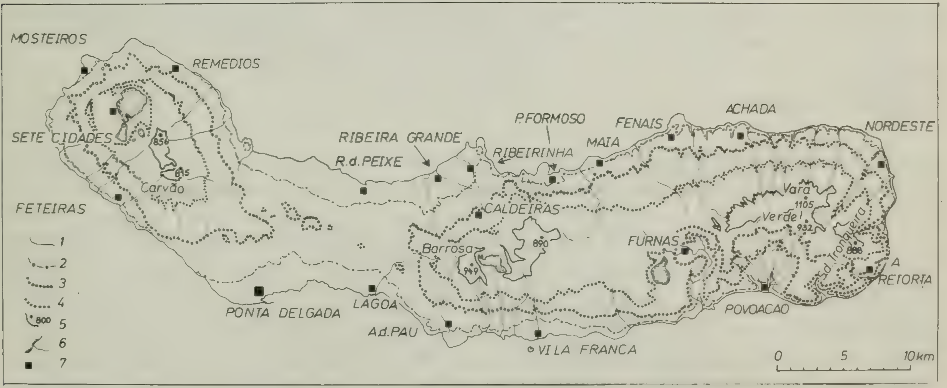

FIGURE 1: Map of São Miguel (Açores). 1 = 0–100 m; 2 = 100–250 m; 3 = 250–450 m; 4 = 450–750 m; 5 = more than 750 m; 6 = lake and stream; 7 = town/village.

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** Glotterbad near Freiburg i.Br., Germany

Photographers: H. and K. Rasbach.

andesitic, and trachytic lavas but nearly the whole surface is covered by volcanic loose material — tuffs and ashes with lapilli and pumice (Zbyszewski et al. 1958, 1959). This soft material can rapidly be colonised by plants.

Besides the small hills, characteristic landscape elements are the volcanic cones, craters (calderas), often containing circular lakes, hot springs, shore cliffs and deep ravines with boulders in the river-beds running down from the high mountains. Some data concerning the climate (Walter & Lieth 1960) can be given here: Ponta Delgada (22 m) has a mean annual rainfall of 69·7 mm which increases in the islands to the west; Angra do Heroismo has 953 mm; Flores (according to Ward, 1970) 1350 — 1800 mm. All stations quoted are in the lower altitudes of the islands. The mean annual temperature in Ponta Delgada is 17.3° C with small differences between summer and winter; the absolute minimum in 30 years has been +4.8° C. Walter & Lieth demonstrate a slight period of dryness in July and August. It has to be remembered, however, that the mountain vegetation gets additional water by frequent fog and clouds as even on clear days one may see "cloud caps" on the mountain peaks. The precipitation map (Fig. 2) is a construction by S. de Brito (1955) according to the records of 16 observation points and extrapolated according to the relief. Below 600 m there is no frost to be expected although on higher mountains the temperatures may occasionally fall below 0° C (Tutin 1953). In spite of the well known azorean anticyclone it is a typical oceanic climate with a number of rainy days and high relative humidity.

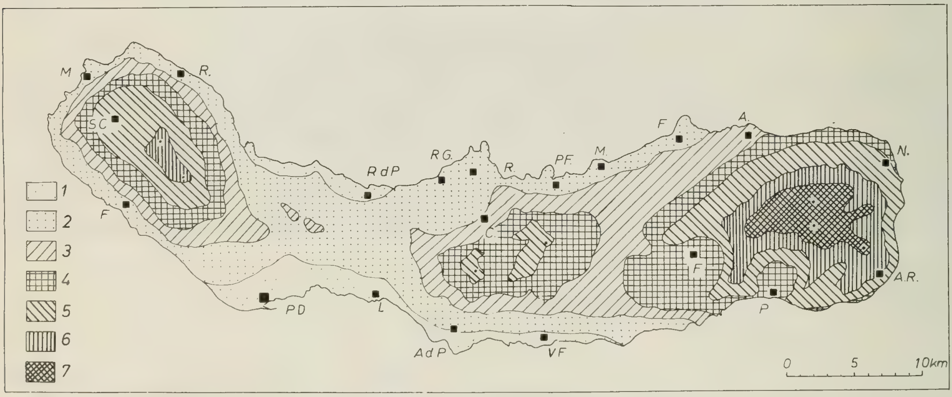

FIGURE 2: Average rainfall. 1 = below 1000 mm; 2 = 1000—1250 mm; 3 = 1250—1500 mm; 4 = 1500—1750 mm; 5 = 1750—2000 mm; 6 = 2000—2250 mm; 7 = above 2250 mm.

Nearly all the vegetation is either totally anthropogenous or at least influenced by man. Tutin (1953) gave the following concept of the original vegetation of the Açores (example Pico). Above the coastal fringe up to ca. 600 m grew an endemic "laurel-forest", the Perseo-Myricetum; from 600 m up to 900 m (a rich form) and to 1500 m (a poor form) he postulated an endemic association with *Erica azorica* and *Juniperus brevifolia* as trees reaching 6 m in height. The summits have been covered in the past with a *Calluna* heath. One can see remnants of the Perseo-Myricetum at steep coastal slopes as an *Erica-Myrica faya*-shrub with naturalized *Pittosporum undulatum.* On steep slopes of gorges one can find stands of the former forest with *Laurus azorica, Ilex perado, Erica azorica* and other endemic taxa. But nowadays the coastal area up to about 200 m is dominated by arable land and vineyards, often small plantations of bananas and citrus fruits behind high hedges as a wind shelter. Higher up pastures are

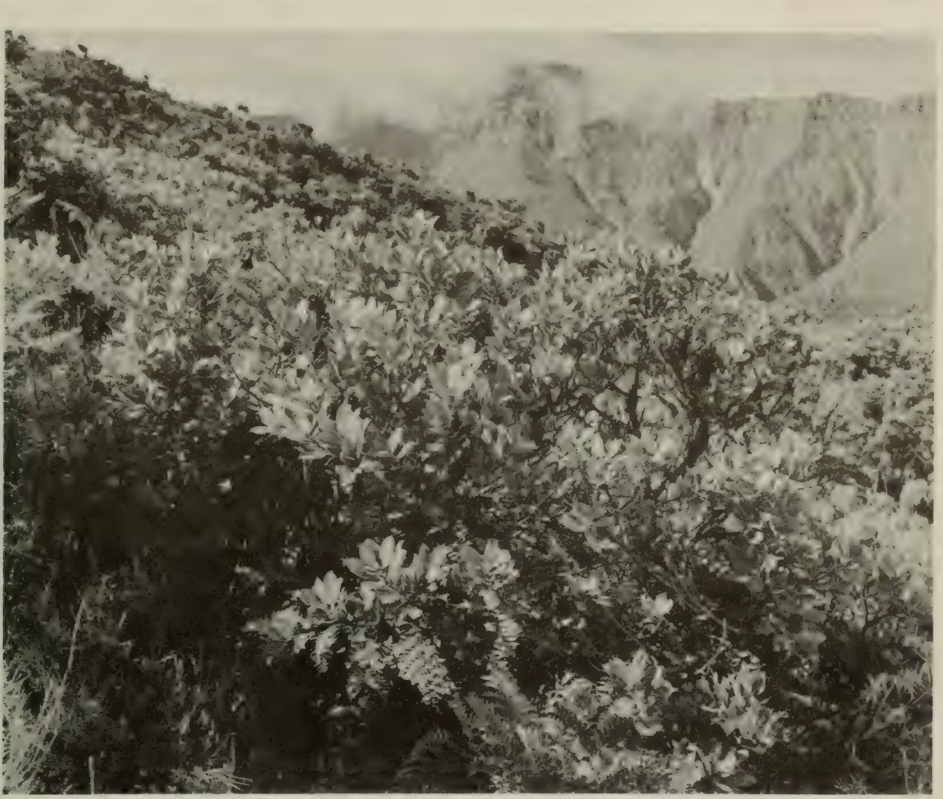

FIGURE 3: Ericetum azoricae with *Erica azorica, Laurus azorica, Calluna vulgaris, Juniperus brevifolia, Culcita macrocarpa.* North-side of Pico Verde, in the background Pico da Vara.

predominant although in the north are some tea plantations. This level also bears vast forests of aliens, mostly *Cryptomeria japonica* and *Acacia* species with masses of *Hedychium gardnerianum (Zingiberaceae).* The Ericetum azoricae is developed nowadays as a sort of shrubby heath. Nevertheless it is the most impressive formation of the island, especially if one takes the trouble to walk through thick *Sphagnum*-carpets and hollows between *Erica azorica* and *Juniperus brevifolia* (rarely more than 3 m high), *Calluna vulgaris, Culcita macrocarpa* plants densely covered with *Hymenophyllum tunbrigense, Myrsine africana, Vaccinium cylindraceum* and other endemics. By felling for timber and charcoal the former wood has changed to heath. ("Pico de Carvão" means "summit of coal"). But even this relict heath is threatened: *Cryptomeria* plantations are pushed forward; in the west and the centre we saw harvesting of heather-sods, people use the heath with *Sphagnum* in the stables instead of straw beds and as a substrate for growing pineapples in greenhouses. Afterwards they often plant pastures.

OBSERVATIONS

Starting from Ponta Delgada, we installed a net of observation lines and points over the island (Fig. 1). This enabled us to characterise each species with respect to (a) frequency, (b) altitude and (c) habitat type. We present our information using the following abbreviations:

(a) **Frequency:**

This is given with respect to the whole island (not to one zone or one habitat type). It would be desirable to give numbers per area unit but this is seldom possible; see Wilmanns (1966). 5 degrees indicate the relative frequency:

vr = very rare (only 1 to 3 localities of max. 100 m^2. The habitat type is mostly so specialized that only very few similar places exist).
r = rare
o = occasional
c = common
vc = very common (in colloquial language "everywhere")

(b) **Altitudinal zones:**

L = from sea level up to 200 m: the cultivated zone
M = from 200 m up to 600 m: the zone with pastures and lower *Cryptomeria* forests with much *Hedychium*
H = above 600 m, the zone with heath and thickets of the Ericetum azoricae and upper *Cryptomeria* forests with diminished *Hedychium*
( ) = rarely in that zone in brackets

(c) **Habitat types:**

F = fissures of rocks and walls (rarely on rock surfaces)
HT = heaths, laurel thickets
P = percolated wet places
R = ruderal sites
S = open slopes (without forest)
W = woody ravines

The nomenclature is mainly based on Flora Europaea i (Tutin et al. 1964) and Carvalho e Vasconcellos (1968).

We did not find *Diphasium madeirense* (Wilce) Rothm., cited for Pico da Vara nor the four species, *Pteris cretica* L., *P. multifida* Poir., *P. tremula* R.Br. and *Doodia caudata* R.Br., which are cited by Carvalho e Vasconcellos (1968) and Palhinha (1966) as subspontaneous. Occasionally, especially in forests of *Cryptomeria* and *Acacia,* we saw tree-ferns (*Alsophila* spp.), escaped from cultivation. Of the following 47 species four are new records for São Miguel and two for the Açores.

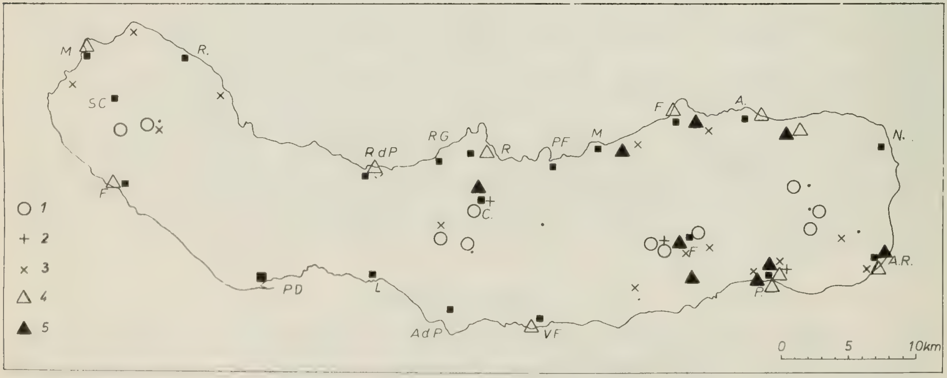

FIGURE 4: Distribution map: 1 = *Lycopodiella cernua;* 2 = *Pityrogramma chrysophylla;* 3 = *Equisetum telmateia;* 4 = *Asplenium marinum;* 5 = *Adiantum capillus-veneris*

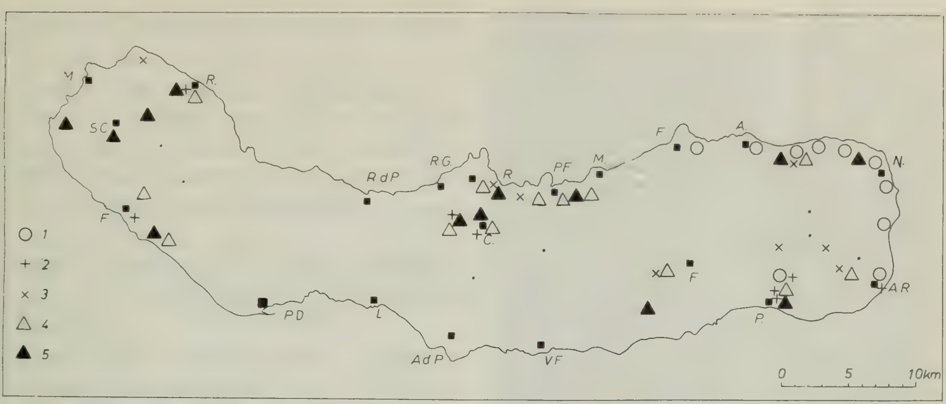

FIGURE 5: Distribution map: 1 = *Asplenium hemionitis;* 2 = *Christella dentata;* 3 = *Pteris serrulata;* 4 = *Diplazium caudatum;* 5 = *Lunathyrium japonicum*

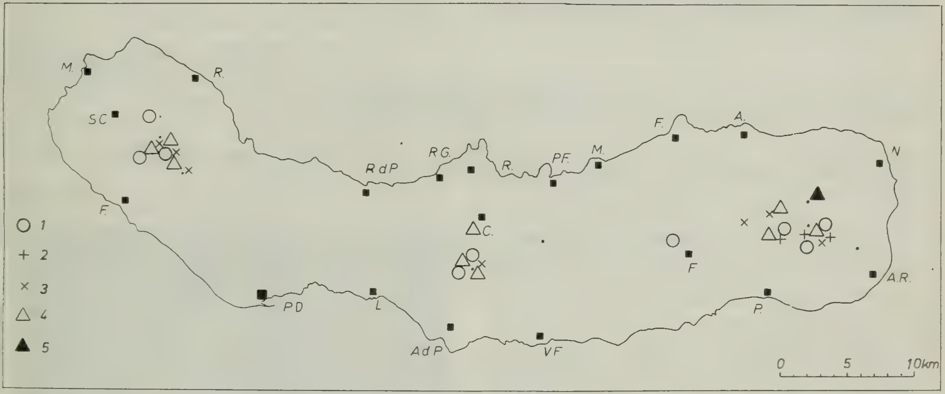

FIGURE 6: Distribution map: 1 = *Culcita macrocarpa;* 2 = *Elaphoglossum paleaceum;* 3 = *Dryopteris aemula;* 4 = *Hymenophyllum tunbrigense;* 5 = *Hymenophyllum wilsonii*

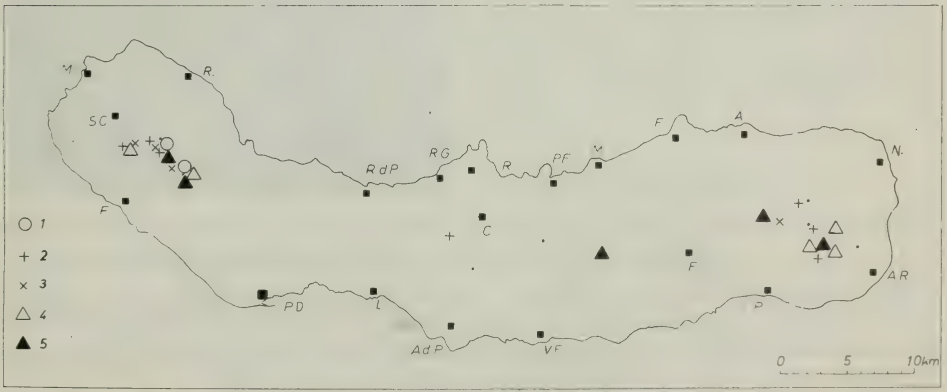

FIGURE 7: Distribution map: 1 = *Trichomanes speciosum;* 2 = *Huperzia selago* subsp. *dentata;* 3 = *Cystopteris fragilis* var. *diaphana;* 4 = *Asplenium monanthes;* 5 = *Stegnogramma pozoi*

Huperzia selago subsp. **selago** (L.) Bernh.
vr / H / HT

This subspecies was seen only once at Pico da Vara about 1000 m alt. in a *Sphagnum* carpet, reaching at least 20 cm depth. The examined specimens of this locality bore leaves without teeth.

Huperzia selago (L.) Bernh. subsp. **dentata** (Herter) Valentine.
r / (M), H / S, HT Fig. 7,8.

On barely overgrown steep walls of ashes and similar soft material, which serves as "soil" for the plant roots, although this maçaronesian endemic subspecies also thrives in moist Sphagna. In these circumstances it was also observed by Ward (1970). The plant evidently requires a high light intensity and is weak in competition with broad-leaved species. Its annual increase must exceed that of the *Sphagnum* and we measured nearly 4 cm/annum on mineral soil.

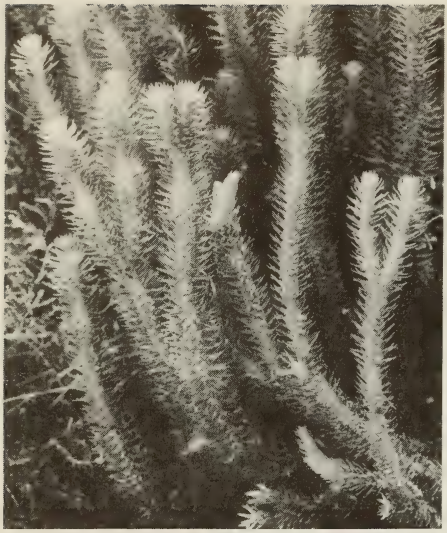

FIGURE 8: *Huperzia selago* subsp. *dentata*.

Lycopodiella cernua (L.) Pic. Ser. (*Lepidotis cernua* (L.) Beauv.)
o / M, H / S, HT Fig. 4,9.

Found on lightly overgrown slopes, often with *Calluna vulgaris*. It seems to be somewhat thermophilous; and is found especially on south-exposed slopes, even though it occurs up to 1000 m. Of note is the combined occurrence with *Pityrogramma chrysophylla* at and near Furnas and at Caldeiras on rocks which are warm by exhalations from the sulphur springs (steam and H_2S). Lötschert (1968) similarly quotes *Lepidotis cernua* and *Pityrogramma calomelanos* for the sulphur springs of San Salvador.

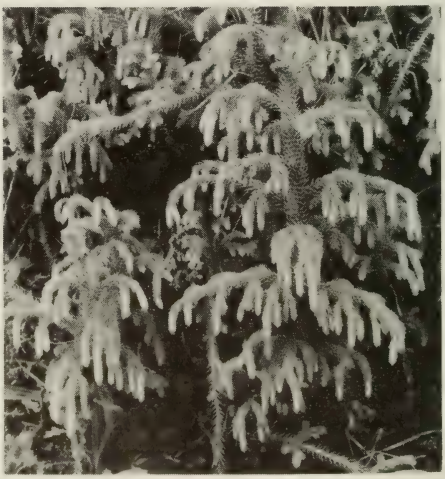

FIGURE 9: *Lycopodiella cernua*.

Selaginella kraussiana (Kunze) A. Braun. vc / L, M / S, F, W

This is the most frequent pteridophyte of the island, on not too dry walls, moist rocks, shaded and unshaded slopes, clearings, between tea-plants, and even on soil beneath not too densely grown *Hedychium* in *Cryptomeria* forests. We never observed it with sporangia; may be the time of the year was not right. Large carpets of *Selaginella kraussiana* demonstrate the importance of vegetative multiplication.

Equisetum ramosissimum Desf. r / L / R

We saw it seven times on roadsides in the grass, where it behaves as a ruderal plant. Possibly this grass-like horsetail can be found "occasionally", but is overlooked. Palhinha (1966) quotes only two localities for São Miguel.

Equisetum arvense L. vr / L / R

This horsetail is not mentioned in the literature on the Açores, although there is a specimen in the herbarium of the Instituto Superior de Agronomia in Lisboa. We observed a group of sterile plants on the northern coastal road, where it is being built near Ribeira de Salga. Probably spores or rhizome pieces are introduced with the machines.

Equisetum telmateia Ehrh. o / L, M, (H) / S, P Fig. 4.

Copious in the central and in the eastern part of the island; and we noted 15 localities where the plant grew mostly as a pioneer on moist or wet loamy soil. Sometimes *Adiantum capillus-veneris* grew nearby and the reader is referred to that species for notes on their preference for calcareous habitats.

Ophioglossum lusitanicum L. vr / L / R

Rothmaler (Flora Europaea I) doubts if this tiny plant lives on the Açores at all, but we recorded it at Feteiras and Agua de Pau; it can be easily overlooked. We found this small Adder's Tongue (without sporangia) twice at a very peculiar and evidently characteristic habitat type: compact soil on rock ribs with little fine earth. There must be an impervious stratum, but the soil dries out superficially and is not completely covered by plants: mosses, some therophytes, e.g. *Vulpia* spec., and some tiny perennials e.g. *Romulea* spec. are the companions of *O. lusitanicum.*

Osmunda regalis L. r / L, H / P

On percolated soils, sometimes near the small watered *Colocasia*-fields; at the border of the Lagoa do Canario. May be, it should be classified as "occasionally", because it is easily overlooked in spring.

Adiantum capillus-veneris L. o / L / F Fig. 4

This species does not grow in such specialized places as in central Europe, because in the maritime climate it is easy for a plant to balance the water budget. It grows on rocks and walls, also (rarely) on travertine, mostly but not always in damp locations, e.g. at a waterfall in Povoação. Near Ague Retorta and Povoação we observed it only 2–6 m above sea-level, so the Maidenhair fern is obviously spray- and salt-tolerant, although the pinnules are browned without windshelter. Whereas this *Adiantum* is calciphytic in central Europe, we saw it on S. Miguel only at one place with formation of travertine; possibly however the other places have a calcium rich rock material and locally it can obtain magnesium if not calcium from the seaspray.

Adiantum cuneatum Langsd. & Fisch. vr / L, M / F

On rocks and walls in damp location (Caldeiras, ravine near Ribeirinha). For São Miguel new (cited for Flores and Faial).

Adiantum hispidulum Swartz o / L / F

Said to be subspontaneous which fits well with our observations. We saw the plant three out of seven times growing on walls inside settlements (Ponta Delgada, Povoação) although it is evidently spreading to natural habitats e.g. wall of the gorge near Ribeirinha and near Caldeiras.

Pteris serrulata Forsskål o / L, M / W Fig. 5

In steep, woody ravines on moist, well aerated soil with good humus content in cool, damp habitats. Reaching a man's height, it therefore even grows between *Hedychium.* At first glance it may be taken for *Woodwardia,* but there are good differences in the marked enlargement of the lowest pinnae (katatony), the lack of the net venation, and the typical arrangement of the submarginal sori.

Pteris vittata L. r / L, (M) / F

In fissures of rather damp walls and rocks, as at Caldeiras and near the waterfall of Povoação. If the water supply is less, the leaves are very small.

Anogramma leptophylla (L.) Link c / L / F, S

Always with sporangia. In wall fissures where they contain fine earth; exuberant on open places on slopes, even in grooves; often together with liverworts. Though often together with *Asplenium* species, it is not really a chasmophytic plant. It tolerates all positions; we found it even on open lava rocks with little earth near the surface (near Rabo de Peixe); but it grows best in positions other than south.

Pityrogramma chrysophylla (Swartz) Link r / L, M / S, F Fig. 4, 10

It was one of our most exciting experiences when we found a tuff wall, warm by gas-exhalations, which was sprinkled with young plantlets of this tropical fern with its golden-dusty leaves. At the same locality, the Lagoa das Furnas, there are also many adult plants on the southwestern slope. Again at Caldeiras this species lives near the fountains under the influence of the warm damp air, where we found plants of the size of our Male ferns. In the literature (Carvalho e Vasconcellos) *Pityrogramma chrysophylla* is only cited for Faial, but in the herbarium (LISJ) are plants collected on São Miguel.

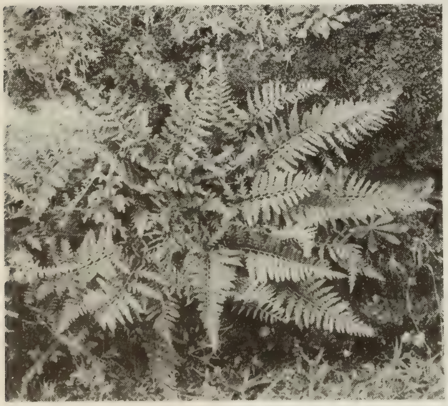

FIGURE 10: *Pityrogramma chrysophylla* with *Lycopodiella cernua*

Pityrogramma calomelanos (L.) Link vr / L, M / F

The tropical character of this african-american plant here at the northern limit of its area is visible in its habitat preference. We saw it on very steep high south-exposed walls formed from volcanic loose material (tuffs and ashes) nearly devoid of other plants, and once in a wall fissure at Povoação.

Culcita macrocarpa C. Presl.
c / (M), H / HT Fig. 6,3,11

One of the most magnificent ferns, which may grow up to a man's height and even to 2 metres in a clear forest. It is a characteristic companion species of the Ericetum azoricae, and is itself a nearly endemic macaronesian species, apart from a few localities in Portugal and Spain (Molesworth Allen 1971). The popular name, Feto abrum, fern of mist, describes the deciding habitat factor. It avoids wind-exposed places. At the Pico Verde (750 m) it grow so luxuriantly that the myriades of spores gave a dust like a ryefield when we roamed through the shrubland. In light plantations of *Cryptomeria japonica,* sterile *Culcita* can survive as a remainder of the original vegetation (e.g. in Nascentes Parques, near Lagoa do Canario). The rhizomes with the decaying leaf bases creep superficially in the *Sphagnum* carpet and form a preferred substrate for bryophytes and — fascinating for the continental botanist — *Hymenophyllum tunbrigense.* In fact this seems to be the only habitat type for the filmy fern, because here below the large *Culcita* leaves the substrate is wet and sheltered from wind. We saw *Culcita* in the mountains of Sete Cidades, Pico de Barrosa, Pico da Vara and Serra de Tronqueira; the lowest locality was at 520 m.

Pteridium aquilinum (L.) Kuhn
vc / L, M / S, R

The most frequent fern on São Miguel, although it avoids the higher cool and rainy mountains. Otherwise it breaks through the soil on open slopes, pastures, arable land, at the foot of walls, along roads. It can even thrive as an epiphyte on leaf bases of tree-fern stems.

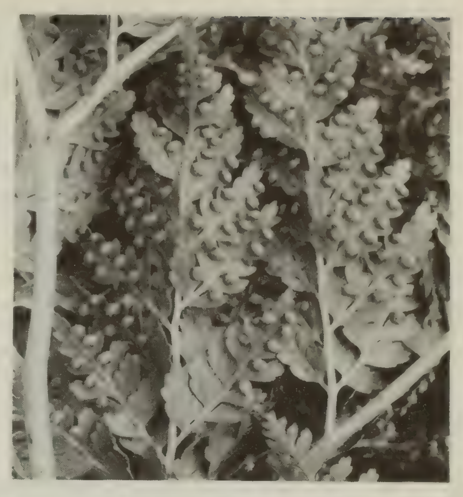

FIGURE 11: *Culcita macrocarpa,* underside with sori.

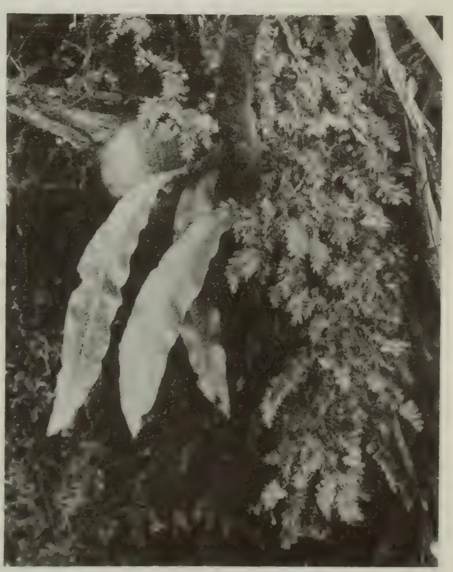

FIGURE 12: *Elaphoglossum paleaceum* and *Hymenophyllum tunbrigense* epiphytic on *Culcita macrocarpa.*

Hymenophyllum tunbrigense (L.) Sm. vc / H / HT Fig. 6,12

This small fern is a hidden but very frequent member of the endemic shrub formation. It grows mostly epiphytically and in very damp ravines it climbs up tree trunks, although if the conditions are less favourable, it is limited to the trunk bases. Also as mentioned before, *Culcita* rhizomes offer an especially good substrate.

Hymenophyllum itself contributes to the formation of its own substrate in collecting moist humus between the network of its tough rhizomes and old petioles. On *Culcita* the filmy fern can live even in southerly-exposed, windy habitats (Pico de Barrosa, 900 m e.g.) being in the shelter of both *Culcita* and other shrubs, while in open *Cryptomeria* forests it can survive as a relic and even climb up on these trunks. It is rarely found on rocks. The species was fertile and luxuriantly sporulating in all places where we saw it but it appeared to need a higher light intensity than its relative *Trichomanes speciosum.*

Hymenophyllum wilsonii Hooker vr / H / HT Fig. 6

After repeatedly checking *Hymenophyllum* plants we finally detected this species in a NE-depression on Pico da Vara at 1080 m on *Juniperus brevifolia,* clothing both the trunk and branches.

Trichomanes speciosum Willd. vr / H / F Fig. 7

It is the most shade-resistant fern on the island being found on rocks in narrow gorges, isolated by forests from direct sunlight and storms, with at least a temporary supply of running water. Even *Hymenophyllum tunbrigense* and *Selaginella kraussiana* are absent in the niches where *Trichomanes* lives and the only other plants present are mosses and liverworts. Though *Trichomanes* is a vascular plant, its life-form is more similar to these adnate plants than to radicant ones. We did not notice any fertile plants at our three localities. In contrast to Benl's findings on Madeira it seems impossible to us that on São Miguel *Trichomanes* can thrive epiphytically and may be accompanied by big forest ferns like *Diplazium* and *Dryopteris.*

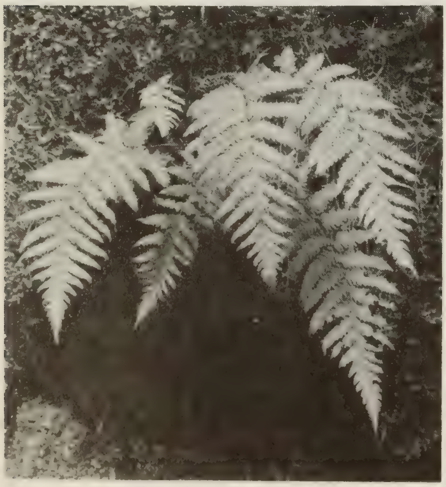

FIGURE 13: *Stegnogramma pozoi.*

Stegnogramma pozoi (Lag.) K. Iwatsuki *(Thelypteris pozoi* (Lag.) C.V. Morton) r / H / S Fig. 7,13

In cool localities with high precipitation on open soils with little competition, in light and shady places.

Christella dentata (Forsskål) Brownsey & Jermy (*Cyclosorus dentatus* (Forsskål) R.-C. Ching) r / L / W, S Fig. 5

The ecology of this tropical-subtropical fern is difficult to sketch. It was found in ravines, but also at the foot of walls and rocks in similar localities to those given by Benl and Ward. Its demands to air humidity are moderate; it seems to prefer a nitrogen-rich substrate.

Asplenium hemionitis L. o / L, (M) / S Fig. 5,14

We paid special attention to this macaronesian-west mediterranean endemic species, particularly when we realized that it is evidently limited to the east of São Miguel. Here it is rather frequent and well developed and on a nitrogen-rich slope we measured 51 cm for the longest leaf. The distribution map (Fig. 5) shows a striking correlation

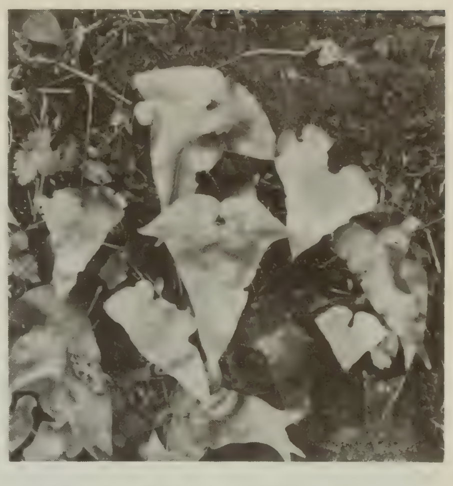

FIGURE 14: *Asplenium hemionitis.*

with that coastal region where the annual rainfall exceeds 1250 mm. The interpretation may be that low winter temperatures as well as low precipitation are limiting factors. Its sensitivity to dryness is further shown by its preference for north-exposed slopes (when growing towards E or W, it is always protected against S). *A. hemionitis* is said to be a plant of wall fissures but this is not true for São Miguel where it is a plant of slopes (as is also *Cyrtomium falcatum*). It only grows on open places which are neither mown nor grazed regularly; that means generally rather steep slopes. Ward (1970) found it on the westernmost azorean island Flores "mainly on dry stone walls". The explanation may be, that the better water reserves of the slopes on S. Miguel are compensated by more precipitation on Flores. That the fern, as Christ (1910) has written, should be "common" on the archipelago, now seems doubtful.

Asplenium marinum L. c / L / F Fig. 4

Found by us on all coastal rocks which have fissures from which fresh water periodically trickles out; impervious strata preventing the water from penetrating deeper in the ground may also be a cause for the occurrence of this fern. It is obviously not strikingly halophilous as we detected it on a wall near Povoacão, in the village Algarvia and found it especially luxuriant in a gorge near Ribeirinha. (Ward gives a record for Flores at 4 km distance from the sea.) These places are less exposed to storms; therefore the plants are thriving better than on open coastal rocks. But how to interpret the frequent and regular occurrence of *A. marinum* on coastal rocks? The fern is not halophilous but halotolerant, more saline resistent than most other species. It is therefore able to hold its position even under extreme conditions as spray, poor supply of fresh water, very little soil, where most other species are eliminated. In its optimal range, however, it has to compete with many other plants — and is supressed. The reason of this weakness in competition is still unknown.

Asplenium monanthes L. r / (M), H / F Fig. 7

This fern can easily be distinguished from the similar *A. trichomanes* by the nearly imbricate, yellow-green, obliquely inserted pinnae, even if the decisive criterion of one sorus per pinna can not be seen. The frequency on single islands of the macaronesian archipelago is rather different: Benl (1971) found it copiously on Madeira, Ward (1970) missed it on Flores despite literature records; we guess, there are few stone walls in the higher mountains of Flores in contrast to the "levadas" on Madeira. Man-made rock walls are its main habitat on São Miguel. There is a rich locality (with ca. 90 plants) at the roadside below the Pico de Carvão (650 m) where the fern passes over to slopes near hedges. There we measured leaves with a length up to 30 cm. At three other places it grew on man-made walls too, whereas we saw it only once in a very shaded humid natural rock fissure near a spring.

Asplenium trichomanes L. o / L, M / F

More drought resistant than *A. monanthes,* but more sensitive than *A. billotii,* although it may grow with both of them. We saw it on walls with and without any influence of lime. Carvalho e Vasconcellos (1968) quotes the subsp. *quadrivalens* D.E. Meyer for São Miguel and for São Jorge the subsp. *trichomanes.* Whereas some plants correspond in appearance to central-European subsp. *quadrivalens,* most specimens differ by brightness, longer pinnae and stronger teeth. We did not see three-winged specimens, i.e. *Asplenium anceps.* Further investigations are in progress.

Asplenium billotii F.W. Schultz c / L / F

A typical fern of siliceous stone wall joints, rarely in rock fissures and even in the stationary scree of the lava flow of Rabo de Peixe, where the fine earth is about 12 cm deep. It is unaffected by exposure and tolerates weak salt influence, a feature also observed by Ward (1970). It may even be accompanied by nitrophilous species as *Parietaria diffusa* and *Urtica dubia.* Though *A. billotii* mostly grows in fissures, the most luxuriant plants are observed in earth as in Guernsey (Channel islands) (Jermy in litt.). Benl (1971) found it on Madeira in "surprisingly dry situations", – indeed, many findings can only be understood by bearing in mind the regular precipitations and the high relative humidity of the maritime region.

Asplenium adiantum-nigrum L. r / L / F

Whether this species in its strict sense (see *A. onopteris* below) really lives in São Miguel is still doubtful. Some "suspected" stocks were seen in wall and rock fissures (e.g. Furnas, Feteiras).

Asplenium onopteris L. o / L, M / S

This species is typically found on shaded slopes. Unfortunately it can not be distinguished easily if plants are poorly developed in consequence of minimal earth cover or water supply then the leaves are reminiscent of those of *A. adiantum-nigrum* or *A. balearicum.*

Phyllitis scolopendrium (L.) Newm. (*Asplenium scolopendrium* L.) r / M, H / S, F

On man-made walls in very damp location in forests, but we even saw it well developed in bordering hedges between pastures and the road from the Pico de Carvão to Relva (450 m, 570 m). As in the eu-atlantic Brittany the Hart's Tongue is not limited to such highly specialized habitats as in continental regions.

Athyrium filix-femina (L.) Roth. c / (L), M, H / W, S

In woods and open slopes. In very damp gorges observed with very short stems (like *Matteuccia struthiopteris* (L.) Tod.)

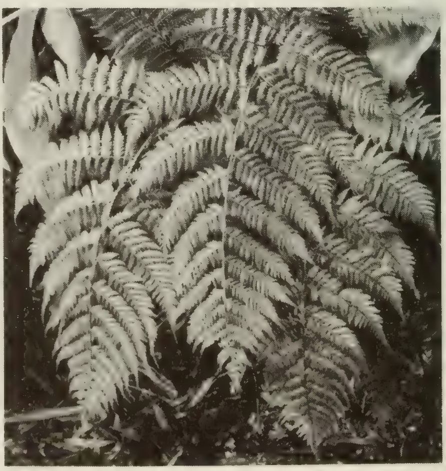

FIGURE 15: *Diplazium caudatum.*

Diplazium caudatum (Cav.) Jermy o / (L), M / W Fig. 5,15

To be found regularly in ravines or similar places with high air humidity. The plant grows always under a tree canopy, and as it can still thrive under *Hedychium* it must be rather shade-resistent. It reaches up to 2 m.

Lunathyrium japonicum agg. (*Diplazium allorgei* Tardieu-Blot)
c / (L), M / S, W Fig. 5,16

If one sees this fern for the first time one may take it for a *Thelypteris,* because its form is similar to a large *Thelypteris phegopteris.* But the type of indusium and two bundles in the petiole are athyrioid characters; also typical are the glandular, hairy leaves. We thank Clive Jermy (London) for his identification, who recently wrote to us "I am indebted to Dr. Sledge (University of Leeds) for drawing my attention to the similarity of the Azores plants to that called *Diplazium lasiopteris* Kunze in Ceylon, (as, in fact, had been suggested by Christ: Bull. Geogr. bot. Mans 17: 159; 1907) but until further studies are made on the group I would suggest you use the aggregate name *L. japonicum (Asplenium japonicum* Thunb.) on which Kurata (J. Geobot. 9: 99; 1961) based his genus *Lunathyrium."*

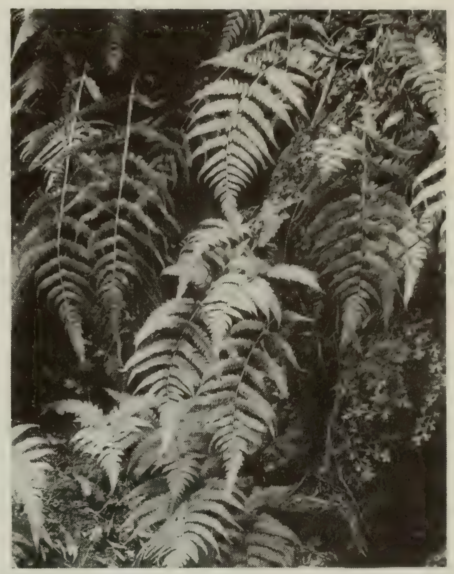

FIGURE 16: *Lunathyrium japonicum.*

Diplazium esculentum (Retz.) Swartz vr / M / R

Only found once; in a rivulet bed with organic waste in Caldeiras, in a locality with temperatures above the average; this fits to the palaeotropical character of this fern. We found it without sporangia, but we could identify it without doubt by the partly anastomosing nerves of the pinnulae.

Cystopteris fragilis (L.) Bernh. var. **diaphana** (Bory) C.Chr. r / H / F Fig. 7

One of the most hygrophilous ferns: in fissures of lava rock in gorges with dripping water or facing northwards; in the district eastwards of Sete Cidades and south of the Pico da Vara.

Polystichum setiferum (Forsskål) Woynar c / L, M / S

It is, as in Brittany, a plant of open slopes and not of forests as in central Europe. So here it is ecologically similar to *Cyrtomium falcatum,* although its centre of distribution is more in the middle zone; the plant seems therefore to need a little more moisture.

Cyrtomium falcatum (L.f.) C. Presl (*Polystichum falcatum* (L.f.) Diels) c / L, (M) / S

The strong leaves, when unfolding are lightgreen and appear varnished. They belong to the typical picture of the slopes, especially in the northern and western part of the island. Rarely found in natural habitats.

Dryopteris borreri Newm. r / H / S, W

We saw rather small plants on slopes and in ditches in open ground along the forest roads.

Dryopteris azorica (Christ) Alston o / M / W

On slopes and similar habitats, under the light canopy of *Cryptomeria* and *Acacia.* Several times we found a form with very narrow leaves, which reminded us of the aspect of *Dryopteris carthusiana.* This may be conspecific with *D. maderensis.* In an *Acacia* forest, 500 m, the leaves reached a length of 1.30 m. The existence of *Dryopteris dilatata* (Hoffm.) A. Gray on the Acores seems very doubtful (Hansen, 1971, Ward 1970).

Dryopteris aemula (Ait.) O.Kuntze o / (M), H / HT, W Fig. 6

In a yellowish green, very spiny toothed form regularly scattered into the Ericetum azoricae, but occasionally in the forest zone on slopes where it is a brighter green in colour. It is not confined to peaty soil.

Elaphoglossum paleaceum (Hook. & Grev.) Sledge (*E. hirtum* (Swartz) C.Chr.) r / H / HT Fig. 6,12

This subtropical epiphyte grows exclusively in the mountains above about 650 m and especially in narrow small gorges with rivulets, which are protected against strong radiation by facing to the north or in another manner. Only single spots of light fall on the long tongues of the fern which may be up to 35 cm long. Rich places are at the Pico Verde (770 m) also on peaty ditchwalls in a shallow northern depression between a high thicket including *Erica azorica, Laurus azorica, Culcita macrocarpa* etc. Strikingly frequent one finds the *Elaphoglossum* on *Ilex perado* together with "usneoid" mosses and Lobarion-lichens; the reason is the often horizontal or obliquely growing trunk of *Ilex,* on which humus accumulates acting as a water reservoir. Whilst *Elaphoglossum* may be easily and regularly detected in these habitats, it seems to be absent on the stormy summits where snow and frost probably prevent its establishment.

Blechnum spicant (L.) Roth vc / (L), M, H / S, HT

Though the Hard fern is not lacking in the coastal district, it is fully developed only in the middle and upper zones where it is one of the most frequent ferns. It is a pioneer of the roadsides, but it also invades the peaty substrate of the heath.

Blechnum homophyllum Merino* vr / L / S

This is a new species for the Açores. We found it only once, although both plentiful and fertile, at the Ribeira de Guilherme near Nordeste, 120 m alt. It was on a northerly-exposed rather steep slope, slightly shaded and accompanied by *Arundo donax, Polystichum setiferum* and a little *Hedychium gardnerianum.* Carvalho e Vasconcellos treats this taxon as a species but A.C. Jermy (in litt.) doubts the validity of it, because in cultivation he finds it reverts to the normal *Blechnum spicant.* Perhaps it will be possible for us to cultivate the azorean plants to see their development.

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* According to new observations (1973) these plants belong to another *Blechnum* spec. not yet determined.

Woodwardia radicans (L.) Sm. vc / (L), M, H / S, W

High humidity and soil moisture seem most favourable for this species. It thrives best on steep slopes in the middle zone, forming hanging thickets and if it were not for the strong competition of *Hedychium gardnerianum,* this would be the dominant fern of the *Cryptomeria* forests.

Polypodium vulgare L. ssp. **azoricum** Vasc. c / L / F

This azorean taxon has been considered a species of its own, *Polypodium azoricum* (Vasc.) R. Fernandes (Fernandes 1968). It looks like a well developed *Polypodium australe* Fée with a relatively broad lamina. Its leaves may reach 40 cm. It is a hemerophitic plant, grows mostly on walls, thriving best directly beneath the upper layer, where most water and fine material is washed into the fissures, although it is also found on natural rocks and on slopes.

ACKNOWLEDGEMENTS

Mrs R.B. Fernandes, Coimbra, has helped us to get literature. Prof. J. Amarel Franco, Lisboa, sent us a list of the azorean pteridophytes represented in the herbarium LISI. Through the help of Prof. T. Reichstein, Basel, we could compare some specimens with his herbarium-material. In the Museo Carlos Machado, Ponta Delgada, we have had the permission to inspect the herbarium. We are very indebted and grateful to them all. We should like to thank the editors of the *Gazette* for helpful criticism of the manuscript.

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REVIEWS

New or reprinted County Floras.

THE FLORA OF THE ISLES OF SCILLY by J.E. Lousley; 336 pp. £4.75: FLORA OF STAFFORDSHIRE by E.S. Edees; 280 pp. £4.20: Both 145 X 222 mm, David & Charles, 1972.

J.E. Lousley's Flora of the Scillies has been long awaited. The first 86 pages give a description of the area including the habitats to be found and discusses man's influence in, and the geographic relationships (especially soil) of, the Channel Islands and European mainland. The book is worth buying for this part alone. Twenty two species of ferns including the established aliens *Blechnum chilense* (Kaulf.) Mett., *Cyrtomium falcatum* Pr. and *Selaginella Kraussiana* (Kze.) A.Br., are recorded on an island basis. *Asplenium ruta-muraria* and *Thelypteris palustris* need confirming and *Dryopteris aemula* has not been recorded since 1893.

In the Flora of Staffordshire E.S. Edees bases his recording on 52 tetrad squares; his introduction makes interesting reading although I would like to have seen his grid superimposed on the physical maps. Thirty eight species are recorded and detailed distribution maps of eight of these are shown. *Huperzia selago* and *Lycopodiella inundatum* need confirming as do *Equisetum hyemale, Hymenophyllum wilsonii, Asplenium viride* and *Pilularia globulifera.*

Both books are clearly laid out and printed and are bound in a similar style.

FLORA OF CHESHIRE by Alan Newton (ed. by James Cullen); 258 pp. 414 maps. 160 X 232 mm. 1971 Cheshire Community Council, Watergate Street, Chester CH1 2LW. Price £2.80 + 20p postage.

This book is so packed with masses of interesting and useful data on the County, its habitats and flowering plants and ferns, that it is money well spent. All the records have been made between 1964 and 1969 with help from many other naturalists. Mr Newton is in touch with botanical taxonomic research in Britain as a whole and frequently enhances his text with hitherto unpublished comments from specialists. Thirty three species of ferns are listed plus eight apparently extinct: *Huperzia selago, Lycopodiella inundata* (listed with the illegitimate name *Lepidotis inundata*), *Selaginella selaginoides, Cryptogramma crispa, Dryopteris cristata, Thelypteris phegopteris, Gymnocarpium dryopteris* and *Pilularia globulifera.*

THE FLORA OF SUSSEX by A.H. Wolley-Dod; 571 pp., 6 pl., one folding map. 145 X 222 mm. 1937, reprinted 1970, Chatford House Press. £5.25.

Again I find the Introductory chapters interesting especially the notes on botanists who had studied the Sussex flora before 1937. The pteridophytes (pp. 535–553) are comprehensive, 41 being listed and to this one can add *Polypodium interjectum* not recognised in 1937; *P. australe* (or *P. vulgare* var. *serratum* Willd.) is listed for four parishes. Discussions on dubious records, eg *Hymenophyllum tunnbrigense* at Cockburl, near Chichester are in full and very informative. For any fern enthusiast who believes there is no longer in Sussex interesting challenges in checking old records, this book is worth its price.

A.C. JERMY.

A FERN COLLECTING EXPEDITION TO CRETE

P.J. BROWNSEY* AND A.C. JERMY**

ABSTRACT

An account is given of a visit to Crete in August 1971 and points of interest arising from the ferns collected are discussed. The status of *Biropteris antri-jovis* Kümmerle is considered and a new combination, *Asplenium scolopendrium* subsp. **antri-jovis** (Kümm.) Brownsey & Jermy, is proposed. New records for the island given are: *Asplenium trichomanes* L. subsp. *inexpectans* Lovis, *Pteridium aquilinum* (L.) Kuhn subsp. *brevipes* (Tausch) Wulf and the Macaronesian species *Cyclosorus dentatus* (Forssk.) Ching [**Christella dentata** (Forssk.) Brownsey & Jermy, **comb. nov.**] A new wild hybrid *Asplenium creticum* X *trichomanes* subsp. *quadrivalens* is also reported.

INTRODUCTION

The island of Kriti (Crete) lies between latitudes 34°55′ and 35°41′N and between longitudes 23°30′ and 26°19′E. Its northernmost point (Cape Spatha) is some 60 miles (96km) from Cape Maléa on the Greek mainland. In general the shape of the island is a narrow oblong some 160 miles (260km) long and 36 miles (60km) broad at its widest point; the area is about 3200 sq miles (832000ha). Administratively it is a province of Greece and is divided into four Departments: Khania, Rethimnon, Iraklion and Lasithi.

The expedition described here was made in August 1971 — not the best month to botanise on Crete. The object of the expedition was, however, to collect fern material from the higher mountains where, especially around suspected permanent snow patches and in the deep clefts of north-facing gullies, spores of some ferns were far from mature and were in fact at the right stage for fixing in acetic-alcohol for chromosome studies. One of us (P.J.B.) made an extensive collection of *Asplenium* species for cultivation at Leeds University as part of a larger project on the *Asplenium lepidum* complex to be submitted for a PhD degree. Apart from the study material for this project other herbarium material collected is deposited in the British Museum (Natural History) and in the Goulandris Natural History Museum, Kifissia. Living material of *Cystopteris, Dryopteris* and *Asplenium* sect. *Phyllitis* is in cultivation at Chelsea Physic Garden, London.

Geology, physical features and climate

Crete owes its geological structure to the complicated earth movements of the Tertiary period that affected the whole of southern Europe and present knowledge of the late geological history of the Aegean area is to be found in the works of RECHINGER (1951), CREUTZBURG (1966) and more recently in the Proceedings of the Symposium on Evolution in the Aegean, held at Lund, (STRID 1971). Basically, however, the entire Aegean region was probably land at the beginning of the Tertiary period, but in Miocene times marine incursions separated the Cyclades and larger islands to the south, firstly from the mainland of Greece in the east and then from Anatolia in the west. This long separation probably accounts for the high degree of endemism in the Cyclades and the specific variation that is associated with plants on

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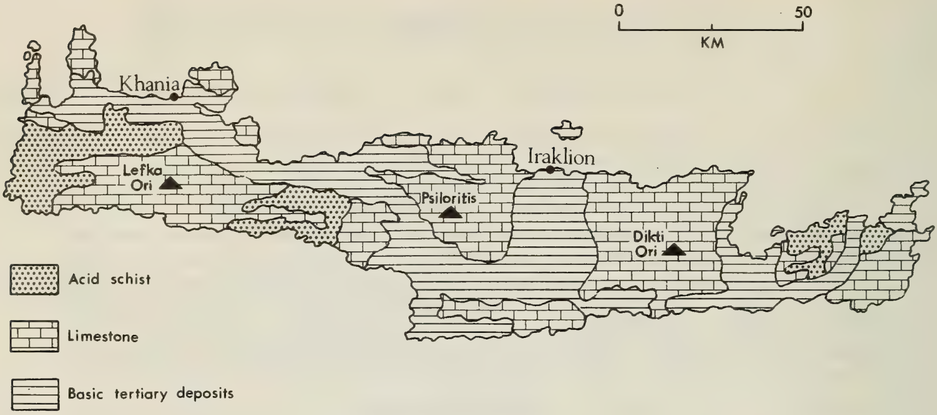

FIGURE 1. Simplified map of solid geology of Crete.

different islands compared to the continuous variation over the mainland from Greece and Bulgaria to Turkey, as shown so clearly, for example, in the *Nigella arvensis* agg. by STRID (1970). Subsequent earth movements with marine incursions and regressions especially in the Pleistocene have left a complicated pattern of small islands to the north separated by the sea of Crete from an arc of larger islands to the south (Kithira, Crete, Kasos, Karpathos, and Rhodes) leading from the Peloponnisos to south west Asia Minor. Much work has been done in the area, especially at the Institute of Systematic Botany, Lund, to establish the relationship between the period of isolation of the various islands and the degree of endemism and variation in different plant groups (RECHINGER 1951; SNOGERUP 1967; STRID 1970 and others). The instability associated with this history has continued to the present day and earthquakes have been frequent in Crete throughout historical times, that of 1856 being the last severe one.

Three major mountain areas are delimited: the Lefka Ori (White Mountains) and subsidiary hills at the western end; the central Psiloritis mountains consisting of Mount Ida (Psiloritis) which, at 8058ft (2687m), is the highest peak on the island, and a number of other peaks almost as high; and the Dikti Ori on the southern edge of the plateau of Lasithi in the east. There is, in addition, a smaller massif to the south-west of Sitia rising to over 4000ft (1400m). All of these have been separated by the sea at various times since the Tertiary.

Geologically the island is almost entirely basic, with limestones by far the commonest rock. The distribution of the main types is shown on Fig. 1 and can be summarised as follows.

1. Metamorphic rocks mainly of Triassic age (and probably the oldest on Crete) which underlie most of the island and best seen outcropping south and west of Khania. They are predominantly slates, mica-schists and quartzite, more rounded in topography and decomposing to give red and yellow clays or sandy soils which are sometimes acidic and hence carry a characteristic flora, e.g. with *Blechnum spicant*.

2. Triassic, Jurassic and Cretaceous rocks, mainly grey-white to jet black coarse-grained limestones which give the typical karst topography seen on most of the island. Mt Mavri (Black Mountain) on the southern edge of the Psiloritis massif

overlooking the Plain of Messara, exemplifies this range of colour well, with light coloured rock at its base and pronounced black limestone at the summit. The Lefka Ori are at the other extreme with endless, featureless blindingly white peaks which have weathered to razor-sharp boulders, quite unlike our limestone pavement.

3. Predominantly freshwater Tertiary deposits, mainly conglomerates and chiefly seen in the lowland isthmuses.

4. Quaternary continental deposits seen in the west and north coastal bays and on the Plain of Messara in particular.

There are no large perennial rivers in Crete; most are seasonal torrents and like most limestone areas, sinkholes and dry valleys abound. Likewise springs are common where the previous limestone meets an impervious rock. Wells often 100ft (30m) deep are also common and characteristic windmills are employed to raise water for irrigation.

Crete enjoys on the whole a mediterranean climate of warm wet winters and hot dry summers. From November to April southerly winds bringing rain to the south coast are nevertheless warm and dust-laden. In summer, winds are predominantly N and NW and still wet having picked up moisture from the Aegean Sea. This can result in areas of high ground over 1000m having summer storms which may last several days, as we experienced in the Dikti mountains during early August. ROSENAN (1965) has presented the rainfall data for 20 stations over a period from 1951 to 1960 and shows clearly that the west of Crete is much wetter than the south and eastern sides. At sea level on the north coast it ranges from 24ins (600mm) in the west to 14ins (350mm) in the east; on the south coast the corresponding values are 18ins (450mm) and 16ins (400mm) respectively. Moreover, the increase in precipitation with altitude is larger in the west (100mm per 100m) than in the east (50–60mm per 100m) – a rate of increase comparable to that of the larger island, Cyprus. Snowfall is comparatively rare at sea level but on the higher ground (5000ft, 1600m) in the Lefka Ori and Psiloritis massifs there is snow cover for most of the winter. In north facing gullies or sink-holes snow patches may persist for the entire summer. The bulk of the snow does not disappear until June, which accounts for our finding ferns still actively meioting on the peaks of the Lefka Ori, whilst only ten miles away on the coast, the vegetation had been burnt up since early June. This tremendous altitudinal variation in freshness of the vegetation over short horizontal distances is a feature of the Cretan flora.

A similar regional pattern is reflected in the air temperature. On the whole (see ZOHARY & ORSHAN 1966) the north west coast is cooler than the south east. At Khania on the north west coast the mean January minimum is 7.7°C, and mean August maximum 30.3°C. At Ierapetra on the south east coast the figures are 7.7°C and 33.6°C respectively indicating a more oceanic climate in the west. In the mountains at Anoghia (2100ft, 700m) in the Psiloritis the January and August means are 7.1°C and 22.5°C. Much of the fern collecting was carried out around 1500m or above on north faces where the air temperature in August averages 15–18°C.

Vegetation

"The present vegetal landscape of Crete is largely the outcome of man's interference during millenia. The climax communities of the vegetation have been largely destroyed and driven back to early stages of succession. These, too, have been, and still are balanced by man" (ZOHARY & ORSHAN 1966, p.13). This quotation is from a detailed account of the vegetation of the island to which the interested reader is referred. Briefly, however, it is typically mediterranean and mainly consists of *maquis* (open scrub of ever-green xerophilous low trees and larger shrubs) and the medium to dwarf, shrub and spiny herb formation known generally as *garigue.* There are remnants, if not larger stands, of deciduous and coniferous forest, especially in the mid-altitudinal regions.

Maquis. This consists of shrubs and low trees not usually exceeding 5m. Two types of this formation were encountered. In the smaller dry river valleys and on the coastal plains generally, *Pistacia lentiscus* L. and *Ceratonia siliqua* L. were dominant species frequently with the wild olive *Olea europaea* L. var. *oleaster* and the oleander *Nerium oleander* L. Here on arenaceous soils *Asplenium onopteris** and *Dryopteris pallida* were found in some quantity, especially in deeper shade.

Another more frequent type of maquis, especially between 300 and 1000m, was that dominated by *Quercus coccifera* L. Although often of great age this species rarely attains tree proportions because of the grazing by sheep and goats. Before the coming of man, however, this oak may well have been a dominant forest species throughout much of Crete. On the schistose siliceous soils south of Khania this type of maquis developed into dense stands together with *Q. ilex* L., *Arbutus unedo* L., *Spartium junceum* L. and *Pistacia terebinthus* L. Amongst and usually beneath this were the undershrubs *Erica verticillata* Forssk. and *E. arborea* L. and *Pteridium aquilinum* ssp. *aquilinum* in the more open situations. Such an association was encountered in a valley between Skinès and Nea Poumata where in 1968 Gradstein and Smittenberg (Greuter pers. comm.) had first collected *Woodwardia radicans.* In this enclave with a somewhat higher rainfall, where the smaller rivers still contained water, a number of ferns characteristic of western oceanic Europe spread successfully, along seepage lines in sandy banks, e.g. *Blechnum spicant, W. radicans, Osmunda regalis* and a small-fronded form of *Adiantum capillus-veneris.* Besides the wild olive, wild pear *Pyrus amygdaliformis* Vill. and the wild almond *Prunus webbii* (Spach) Vierh. are common trees in this formation and are often left as boundary or hedgerow trees, e.g. in the Lasithi plateau.

Garigue. Basically this is the typical mediterranean vegetation cover consisting of dwarf shrubs and xerophilous herb species which are for the most part arrested stages of the sere to climax woodland that have been kept in check by man's cutting for fuel and grazing. A distinct feature is the spiny habit and tough, often reduced coriaceous leaves. Common species are *Poterium spinosum* L., *Ononis spinosa* L., *Cytisus creticus* Boiss. & Heldr., *Berberis cretica* L., *Teucrium divaricatum* Sieb., *Phlomis lanata* Willd., *P. fruticosa* L., etc. Associations are difficult to delimit but on the whole this formation is commoner on eroded sites, especially of limestone and skeletal soils. The garigue is poor in ferns apart from limestone outcrops which are the home of *Asplenium ceterach, Cheilanthes pteridioides* and *Selaginella denticulata* (all of which must spend the summer months as brown shrivelled masses only to recover *in toto* at the onslaught of the autumn rains). *Adiantum capillus-veneris* and other *Asplenium* species sometimes occur.

Woodland. Throughout much of Crete woodland is only represented by scattered trees or remnant groups, the island having reputedly been heavily forested in Minoan times. This is due to a number of climatic, edaphic and historical factors. Nevertheless, we encountered areas whose dominant plants were tree species and also large areas of hillside which were open scrub with a large proportion of mature and obviously old trees 10–12m high. The following are typical woodland associations. (a) **Pine woods.** *Pinus brutia* Ten. ranges from sea level to 1200m, mostly on skeletal calcareous soils, often co-dominant with *Acer sempervirens* L. (e.g. on the south side of Mavri). (b) **Cypress woods.** *Cupressus sempervirens* L. is present throughout the altitudinal range of the pine woods and extends higher to 1500m. Particularly good stands of this formation were seen in the Volikas valley near Kampi, but this tree, which once covered large tracts of Crete suffered considerably in Minoan and classical times as an export product and now has only a fraction of its former distribution. This valley at Volikas on the north slopes of the Lefka Ori is steep sided and although dry when we visited it in August was obviously lush earlier in the year. Between 1200m and 1500m we found *Asplenium trichomanes* subsp. *quadrivalens* and subsp. *inexpectans, A. scolopendrium* subsp. *antri-jovis, Dryopteris pallida* and *Selaginella denticulata.* Although the balance between dominants in these conifer woods is delicate there is a tendency for the pine woods to be on the south facing slopes of the Lefka Ori, Psiloritis and Dikti Ori and the cypress woods on the northern slopes. (c) **Oak woods.** These were represented principally as scattered individuals or small stands of *Quercus pubescens* Willd. Although stated by ZOHARY & ORSHAN (1965) to go up to 850m, this association was not encountered by us in any density. What we saw of it, e.g. on the north east slopes of the Psiloritis, was open and contained nothing in the way of ferns. (d) **Plane woods.** These are dominated by *Plantanus orientalis* L. and seen in the valleys and along water courses especially on sandy or schistose rocks. The only associated ferns were *Dryopteris pallida* and *Selaginella denticulata.* (e) **Chestnut woods** (*Castanea sativa* Miller). These were the nearest thing to a western European mesotrophic wood encountered and were seen south of Khania near Eli. On the moist banks of rivulets, *Athyrium filix-femina, Dryopteris pallida* (often looking like *D. filix-mas*), *Blechnum spicant* and *Selaginella denticulata* were common and well grown.

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* Authorities for fern names are to be found in the list on p. 346–7

Alpine communities. In the mountains above 5000ft (1700m) the *garigue* usually contained a dominant species in the form of *Berberis cretica.* Others such as *Poterium spinosa* and *Sideritis syriaca* L. (used to make a refreshing drink) were also present. Above 1800m, and apart from in sheltered corries, bush communities disappeared and gave way to a very open type of habitat. The interesting ferns at this height were in limestone crevices or gullies and under overhangs facing north. *Polystichum lonchitis* and *Dryopteris pallida* were present at 1500m but above this, apart from the *Cystopteris fragilis* complex, there were exclusively *Asplenium* species (*A. trichomanes* subsp. *quadrivalens* and subsp. *inexpectans, A. haussknechtii, A. creticum, A. ruta-muraria, A. aegaeum* and *A. scolopendrium* subsp. *antri-jovis*).

River valleys and wetlands. There are very few swamps in Crete and those that do exist are mainly at the mouth of rivers. Where water is still running the commonest and almost only fern is *Adiantum capillus-veneris* on both limestone and sandstone. The other common pteridophyte here is *Equisetum ramosissimum*, which often attains several metres in height scrambling amongst the vegetation at the side of a stream. Frequently it is not branched for the lower 2m and the stem is quite thick, reminding one of *E. hyemale* L. *E. telmateia*, the only other species of this genus known on Crete, is uncommon, but was found in a seasonally dry stream bed at Kambos in West Crete.

ITINERARY

Our first three days in Greece were spent as the guests of Mr and Mrs Goulandris at Kifissia where we were able to study previous collections from Crete now in the herbarium of the Goulandris Natural History Museum. We flew into Iraklion to be met by a local botanist and temporary collector for the Goulandris Museum, John Petamidis, who acted as interpreter, liaison officer and guide.

There is probably the most efficient local bus service in Europe connecting the small villages of Crete but the time-tables are such as to bring villagers to town rather than visitors into the country. We had decided therefore to hire a car and started our collecting around Iraklion itself, notably at Fodhele, where we searched in vain for *Pteris vittata.* We made our first serious trip into the mountains on 9 August to the Dikti Ori. In the cool of the late afternoon, led by guide and mule, we climbed the north face of Spathi to Avarsami with ever increasingly spectacular views below of the Plain of Lasithi — a highly fertile natural amphitheatre covered with many thousands of windmills. We slept at 4000ft in the open beside the only spring on the mountain and next morning went on to 6500ft (c.2000m) to find small populations of *Asplenium creticum, A. haussknechtii* (a fern of Asia Minor only recently found on Crete), *A. trichomanes* subsp. *quadrivalens* and *Cystopteris fragilis* agg. Before we could do any serious work, however, we were enveloped in cloud and subsequently torrential rain blown in by a bitter wind from the north. It was impossible to re-find our bivouac and we took compass bearings to the col that led down to the Lasithi plateau. We spent three days waiting for the mountain to clear, collecting around Potami in Lasithi and Knossos, near Iraklion, before taking the guide and mule to retrieve our gear from Avarsami.

Our next objective was Mt Mavri to the south of Mt Ida in the Psiloritis massif. We had initially explored the northern part of this group by road from Anoghia to find in the maquis little in the way of ferns except *Asplenium ceterach* and *Selaginella denticulata* both appearing very burnt and shrivelled. The leaves of the former are easily revived on wetting which happens on most nights allowing them a few hours of metabolic activity before the heat of the early morning sun dries them out again.

Mavri is almost devoid of springs and we were compelled to climb over to the north side and back in one blisteringly hot day, some 4000ft in each direction. Just two spots on the mountain proved pteridologically interesting — one, to the north of the peak yielded a colony of *Asplenium aegaeum* together with *A. ruta-muraria* and *Cystopteris.* The other, in a deep cleft just below the famous Kamares cave, contained perhaps six plants of equivocal status. Grown at Leeds from spores, those plants are probably *A. haussknechtii* but differ morphologically from other Cretan collections of this species.

Subsequently we moved to the western end of the island and made a more ambitious foray into the White Mountains from the village of Kampi, due south of Khania. Once more with guide and, this time, donkey, we climbed on the evening of 10th August to the Greek Alpine Club Hut at Volikas (1500m). In the north-facing valley leading to the Hut we found interesting variants of *A. trichomanes* subsp. *quadrivalens* and at least three plants of *A. trichomanes* subsp. *inexpectans* — a new record for Crete. Also in abundance were *Dryopteris pallida, A. ceterach* and *Cheilanthes.* Above the Hut the terrain became very open and featureless and we arrived after a day's walk at Livada where we stayed in a 16th century stone dwelling. The two shepherds, our hosts, though living in primitive isolation, prospered on the production of cheese from sheep's milk. For two damp, misty days we explored the immediate vicinity of Livada feeling thankful for a guide. *A. aegaeum* was abundant, as was *A. creticum.* On Mt Hagios Pnevma we found the interesting hybrid *Asplenium creticum* X *trichomanes* subsp. *quadrivalens*, together with its parents. Lower down on our way back to the Hut we found *A. scolopendrium* subsp. *antri-jovis*, the small hart's-tongue first named (and put into a new genus) *Biropteris antri-jovis* by the Hungarian botanist J.B. Kümmerle in 1922. This was a plant we were anxious to get into cultivation and has subsequently turned out to be a form of our own hart's-tongue (v.i.). Elsewhere *Asplenium*, and forms of *Cystopteris* often looking remarkably like *A. aegaeum*, dominated the vegetation especially in the large sink-holes and north-facing crevices.

Our return to Khania was brisk and we turned our attention to the lower altitudes, to the well-wooded valleys on the outcrops of schist, south-west of the town. Between Nea Poumata and Skinés we found the small waterfall noted by Dr Greuter as a locality for the Atlantic fern *Woodwardia radicans.* Here in a wet and shady gully in an otherwise dry woodland was a plant with fronds over two metres long. Further up the valley with *Blechnum spicant* were other smaller plants. Nearer Skinés, in an orange grove, on the vertical clay sides of an irrigation channel we found several plants of *Christella dentata (Cyclosorus dentatus)* for the first time on Crete. As far as Europe is concerned it has hitherto been found only in the Açores and S Spain, but the species, first described from the Yemen, is known across Africa south of the Sahara and the possibility of its entry into Europe from the south must not therefore be discounted.

For the last few days we drove to the extreme west hoping to find more Atlantic species, especially *Asplenium adiantum-nigrum* and *A. billotii*, but in vain. We returned to Iraklion and had a final one-day trip to the Dikti Ori to climb Spathi, this time in fine weather. We were rewarded with fine views of the whole island together with good collections of *A. haussknechtii* and *A. aegaeum.* At the very end of August we returned to Kifissia and thence to London.

NOTES ON INDIVIDUAL SPECIES

Equisetum ramosissimum Desf. This species is common in thickets by water courses and often becomes straggly and up to 3m in height thus giving rise to a number of growth forms very similar to *E. hyemale*, a species recorded in the literature for Crete but not so far confirmed. Young secondary shoots of *E. ramosissimum*, when growing in wet gravel, may in the past have been confused superficially with *E. palustre* L. another species whose reported occurrence may be due to error.

Pteridium aquilinum (L.) Kuhn. Stature, leaf dissection and degree of hairiness are variable throughout the range of this species. A population found on the Lasithi plateau near Potami at 1000m (J 9000) was quite distinct in the field from the more normal, stunted bracken growing in sandy places to the east of Iraklion. The short (<35cm) pinnae were held almost upright, the lamina was densely hairy beneath and very thick, the whole frond having a grey appearance. This agrees well with material of *P. aquilinum* subsp. *brevipes* (Tausch) Wulf, noted by VALENTINE (Fl. Eur. 1: 12; 1964) as present in the Crimea and Caucasia. This apparent extension of subsp. *brevipes* to Crete is of interest in relation to its possible occurrence in Turkey, and also to a limestone form recently described from Spain as *P. herediae* (Clemente ex Colmeiro) Löve & Kjellqvist and reported as diploid (2n=52) (LÖVE & KJELLQVIST 1972). This is morphologically very similar to subsp. *brevipes* and the two may be synonymous thus supporting the suggestion of the above authors that "*P. herediae* may be a plant of Tethyan distribution, surviving in calcareous areas in south Europe...."

Christella dentata (Forssk.) Brownsey & Jermy. As far as Europe is concerned this species, as *Cyclosorus dentatus* (Forssk.) Ching has long been recorded for the Açores and is common on the Macaronesian islands of Madeira, Canaries and Cape Verde. It is widespread in Africa through to Arabia and closely related species are found in tropical Asia. In 1968 Mrs B.M. Allen found it locally common in the Los Barrios district of Cadiz, Spain (MOLESWORTH-ALLEN 1971) where it is being rapidly overgrown despite attempts to save it (B.M.-A. pers. comm.). On Crete it was found by us for the first time near Skinès, Khania (J 9251, 9252) beside irrigation channels in an orange grove where the vertical stiff red-brown loam gives a ready surface for spore germination and prothallial development. With it were *Athyrium filix-femina* and *Osmunda regalis.* Material fixed in the field has proved to be tetraploid. In view of the revision of the Old World Thelypteridaceae and the redefining of *Cyclosorus* Link by HOLTTUM (1971) this species should be treated as a species of *Christella* Lév., namely **Christella dentata** (Forssk.) Brownsey & Jermy **comb. nov.** (bas.: *Polypodium dentatum* Forssk. Fl. Aegypt.-Arab. 185; 1775).

Asplenium trichomanes L. Hitherto only tetraploid plants of this species had been found on the island although ZAFFRAN (1970) reported *A. trichomanes* subsp. *trichomanes* from all three main mountain areas. However, since these are entirely limestone areas and subsp. *trichomanes* a calcifuge, this is clearly an erroneous identification, as pointed out by REICHSTEIN et al. (1973) and confirmed by our own observations. Tetraploid plants (subsp. *quadrivalens* D.E. Meyer) were found by us on the three principal mountain peaks. In a valley below Volikas between 1200–1400m plants (J 9213, J 9231) having large terminal pinnae and abruptly ending fronds were suggestive of ssp. *inexpectans* Lovis. Subsequent fixings of live plants (C78–C82) brought back to Leeds have confirmed their diploid nature. Populations of subsp. *inexpectans* are not common in Europe and this one appears to be distinct in morphology from those of Austria and Pelijesac in Yugoslavia but rather similar to collections from the Taygetos mountains further to the north of Greece. The fronds are clearly distinct from subsp. *trichomanes*, being much more abruptly terminated but having pinnae squarely inserted and with a large terminal pinna. The tetraploid plants of Crete are, however, much less easily distinguished, especially in the field, whilst one collection from Ikaria, another Greek island, is only separable on the basis of chromosome number. Thus, although the diploid subspecies of *A. trichomanes* are not easily confused, subspp. *inexpectans* and *quadrivalens* are even more similar in eastern Europe than they are in central Europe.

Asplenium adiantum-nigrum complex. Material collected at Nea Poumata (J 9280) and 3km south of Kambos (J 9306, 9305) showed the more typical lanceolate pinnae with rounder, broader, obtusely toothed pinnules of *A. adiantum-nigrum.* Subsequent chromosome counts, however, have shown all our material to be diploid and therefore presumably referable to *A. onopteris.* Possibly the dubious records of *A. adiantum-nigrum* are based on this same misconception. More typical plants of *A. onopteris* were common in shady, well-drained banks often under dense scrub of *Erica, Arbutus* and *Pistacia.*

Asplenium aegaeum Lovis & Reichstein. This species, first collected by Zaffran in 1965 and subsequently by Greuter, was cultured by Reichstein and found to be a new diploid species so far endemic to Crete. A full account of experimental work carried out in the last six years appears in REICHSTEIN et al. (1973). Further to the collections seen by these authors from Dikti and Lefka Ori, we have found *A. aegaeum* on Mavri (north face at 1900m: *C21, C26* [cult. Leeds], J 9098 [BM]). On all three main mountain masses it was variable: that in open crevices smaller, more coriaceous, yellow-green and with the leaves often curled resembling *A. lepidum* C. Presl; that in deeper shaded fissures was very dissected and with thin leaves having the general appearance of *A. fissum* Kit., a species recorded by ZAFFRAN (1970) possibly in error for *A. aegaeum.* Confusion with these other two species may account for its having been overlooked as a new taxon for so long since in the Lefka Ori it is the most widespread of all ferns at the highest altitudes.

Asplenium creticum Lovis, Reichstein & Zaffran. This species was again first found by Zaffran in 1965 and is described by REICHSTEIN et al. (1973) where comparisons are also made with *A. daghestanicum* Christ from Central Asia and *A. quezelii* Tardieu from Tibetsi. It is probably an alloploid based on the two diploid species *A. aegaeum* and *A. viride* Huds. Since *A. creticum* is also endemic to Crete and restricted to the highest peaks of the Dikti and Lefka Ori it would have been interesting to have confirmed the presence of the third plant *A. viride* but despite a thorough search of likely areas nothing was found and we are left with three very young plants collected by Zaffran from the Lefka Ori as the only record of this species on Crete.

A. creticum X **trichomanes** subsp. **quadrivalens.** A single plant of this putative parentage was found at 7000ft. (2100m) in the Lefka Ori just to the NE of the Livada plateau growing with its parents. Fixings made at the time and several taken since from the plant in cultivation at Leeds show approximately 36 bivalents and 72 univalents. The further significance and description of this new hybrid will be discussed in a future paper (Brownsey in prep.) in relation to a similar hybrid produced artifically at Basel.

Asplenium haussknechtii Godet & Reuter. This taxon was probably first found on Crete in 1904 by Dörfler but not recognised as such by him (REICHSTEIN et al. 1973). It was subsequently found by Zaffran in 1965 in the Dikti Ori (ZAFFRAN 1970) and by Greuter in 1971. Regrettably, Zaffran also reported it from the Lefka Ori but his specimens are now known to have been misidentified. We collected it on Dikti and can confirm its presence in the Psiloritis, (as postulated by REICHSTEIN et al. (1973) [*C9* (in cult. at Leeds) from N side of Mavri at 1800m]. *A. haussknechtii* was first described from the Malatya region of southern Turkey and more recently recorded from several villeyets by HENDERSON (in DAVIS 1965). Its distribution ranges from Crete to Afghanistan, from where it is often referred to as *A. samarkandense* Kossinsky.

A. haussknechtii is a tetraploid of alloploid origin (LOVIS, BROWNSEY, SLEEP & SHIVAS 1973), with one parent as *A. ruta-muraria* L. subsp. *dolomiticum* Lovis & Reichstein, (Brownsey in prep.) and very closely related to *A. lepidum* which is similarly alloploid and shares the same parent (VIDA 1972). REICHSTEIN et al. (1973) suggest that *A. haussknechtii* in fact has similar genomes to those of *A. lepidum*, postulating *A. aegaeum* as the second parent, and that *A. haussknechtii* should perhaps be regarded as a subspecies of *A. lepidum.* That *A. aegaeum* is in fact the second parent of *A. haussknechtii* and that there is complete pairing between the genomes of *A. lepidum* and *A. haussknechtii* has now been shown (Brownsey in prep.). A thorough search was made for *A. ruta-muraria* subsp. *dolomiticum* on Crete and several possible plants were collected but all have proved to be tetraploid. However, we still feel that conditions on the island are right for the persistence of a diploid form. Similarly extensive collecting in southern Turkey may reveal both parents of *A. haussknechtii* but whilst the fact of a phytogeographical connection between the Balkans and Asia Minor is no longer in doubt the question of the direction of spread of these *Asplenium* species either east or west is still mere speculation.

In the field *A. lepidum* is distinguished from *A. haussknechtii* on the basis of its pronounced glands. By this criterion undisputed *A. lepidum* is found only in the Lefka Ori in the west, and equally distinctive *A. haussknechtii* only on Dikti in the east. Plants from Mavri in the centre of the island appear quite distinct morphologically but must still be labelled *A. haussknechtii.* However, *A. aegaeum* is also glandular, though less so than *A. lepidum,* and less readily separated. It is a delicate plant, especially in shade, but often grows abundantly in limestone crevices to the exclusion of everything else. A good field character is the hooded (allantoid) indusium which is quite distinct from the large fimbriate indusia of either *A. lepidum* or *A. haussknechtii. A. ruta-muraria* may also be confused with *A. haussknechtii* but is always more coriaceous and a darker green in colour. The spores are the most distinctive character and are shown in Plate XXVIII E–G; those of *A. haussknechtii* appearing less rugose and finely papillate under the light microscope. Those of *A. ruta-muraria* are cristate, the crests often forming large ridges which appear sharper in subsp. *dolomiticum.* The latter also has a scattering of fine papillae.

Asplenium scolopendrium subsp. **antri-jovis** (Kümm.) Brownsey & Jermy. This species was originally collected by Ludovici Biró in 1906 from the mouth of Žeus's cave at 1450m on Mt Ida (Psiloritis). It was described by KUMMERLE (1922) as *Biropteris antri-jovis*, a small, delicate fern with ovate, lobed, sterile leaves up to 4cm long, and narrowly-lanceolate, laciniate, fertile fronds somewhat smaller in size. The bases of the fronds were sometimes cordate, sometimes broad, whilst the venation was characterised by the absence of a distinct mid-rib. The stipe in cross-section displayed three vascular bundles. The sori were linear, solitary, extending to the incut parts of the lamina edge and covered by unilaterally attached indusia with undulate margins. Dehiscence was extrorse.

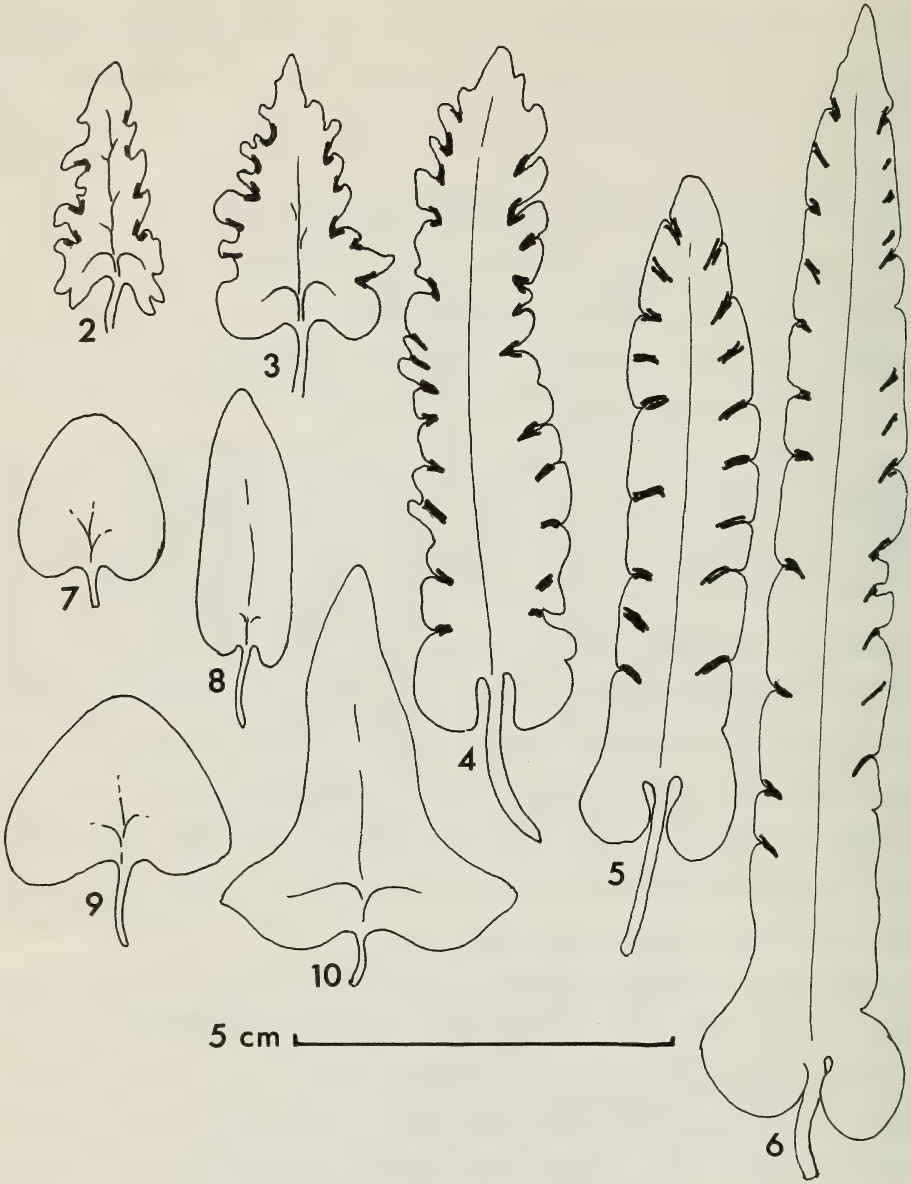
Kümmerle was impressed by four main features of the plant which taken together exceeded the generic limits of both *Phyllitis* and *Asplenium* and he therefore created a new genus intermediate between the two. He laid great emphasis on the lack of a mid-rib, describing three veins entering the base of the lamina, two of which branched laterally and dichotomously at the base. The third extended upwards dichotomizing to left and right with the branchlets themselves dichotomizing, but all terminating in thickened apices just short of the lamina edge. The pattern of veins in the petiole was also characteristically different from either *Phyllitis* or *Asplenium.* He attached some importance to the apparently dimorphic fronds — namely the ovate sterile leaves and smaller lanceolate highly dissected fertile leaves. His fourth point concerned the sori, which were single, linear and extended to the leaf margin with extrorse dehiscence and were thus unlike either the paired sori of *Phyllitis* or the introrsely dehiscing sorus of *Asplenium.*

Since 1906 several collections of this enigmatic plant have been made. RECHINGER (1943) made his own collections on Psiloritis and described a whole series of juvenile frond-types from heart- or kidney-shapes with palmate venation to highly dissected elongated fronds with pinnate venation; and a range of mature fertile examples, from fronds with laciniate edges to fronds with entire margins. He found little correlation of this variation with changes in humidity or exposure, and he thought these plants were probably variants of *A. sagittatum.* This point of view was accepted by VALENTINE (1964) who suggested that plants described as *B. antri-jovis* from Crete "may be monstrous forms" of *A. sagittatum.*

More recently, in 1961, Dr W. Greuter collected material from Psiloritis which was altogether larger than that illustrated by Kümmerle or Rechinger. This has been cultured (from spores) in Basel by Reichstein and at Leeds since 1963 by Lovis and two such fronds are shown here (Figs.3 & 4). The larger frond shows clearly the indented margins to which the sori extend on the underside; the smaller (and very much younger) more irregular frond is almost identical to that illustrated by Kümmerle (Fig.2). It is worth noting that the characters of the wild material (i.e. the dissected fronds and the marginal sori) have been maintained in culture and are therefore genetically based. However, the Greuter's original collection did differ from that of Biro's in possessing a good mid-rib and paired sori.

The present authors were unable to visit the 'locus classicus' but did collect material resembling *B. antri-jovis* on Mavri, which is part of the Psiloritis range (immature plants only) and in the Lefka Ori, where two populations were found showing a range of morphology. One, in Volikas valley at 1200m was in a deep chasm between limestone rock at the base of which water obviously passed in quantity earlier in the year. Leaves up to 20cm long by 2cm wide were found and on fertile plants a few fronds were irregularly lobed or lacerate with marginal sori visible at maturity from the upper side. (Fig.5). The overall appearance of many fronds was similar to that of young *A. scolopendrium* and, compared with fronds of *A. sagittatum* of similar age and size, they lacked the slightly but distinctly angular lobes at the base of the lamina, which are seen even on young plants (cf. Figs.7–10). In the second population on a shaded ledge facing north east at about 1800m plants of all sizes were growing together and the largest attained 10cm. Young plants brought back and grown in pots in a culture cabinet at 22°C–24°C for 12 hours light and at 14°C for 12 hours dark at 60% relative humidity produced a new flush of fertile fronds which were entire and lacked the irregular cutting of those grown in the wild. A degree of phenotypic plasticity therefore seems to be involved. Chromosome counts on plants from this locality indicate that they are diploid with $n = 36$.

Cultivation of material brought in from the wild has revealed several interesting facts. In the first place we can now put Biró's material into perspective. Kümmerle describes it as having about 15 fronds most of which are sterile and the largest only 4cm long. This and other parts of the description leave one with the overwhelming impression that he is dealing with a very young or environmentally retarded plant. It was collected in June which at 1450m on Crete would have been extremely early in its growing season, and from rock fissures at the mouth of a cave which might not be the ideal environment for luxurious growth. Indeed we found plants of equivalent size in a similar position on Mavri which were obviously immature and it was impossible to identify them accurately at that stage. Zaffran also has made collections of young plants which fit Kümmerle's description but which are otherwise unidentifiable. Assuming, then, that Kümmerle's material was immature we can make certain deductions. The fronds he describes would presumably have been primordial leaves and might reasonably be expected to have been variable. More importantly, the dimorphism he describes between sterile and fertile fronds is a natural result of the transition from juvenile to more mature foliage and is no greater than in any other



FIGURES 2—10. Fronds of *Asplenium sagittatum — scolopendrium*. **2**: *Biropteris antri-jovis,* type material (after Kümmerle). **3** & **4**: *A. scolopendrium* subsp. *antri-jovis,* coll. Greuter, 1961. **5**: *ibid.* coll. Jermy & Brownsey J9227. **6**: *A. scolopendrium,* Levens Park, Yorks., coll. Lovis & Vida. **7** & **8**: juvenile subsp. *antri-jovis,* J9195/2. **9** & **10**: juvenile *A. sagittatum,* Baleares, coll. Cannon, 1970.

species of *Asplenium* of equivalent age. In this case the extremely laciniate fertile frond illustrated by him (Fig.2) is very similar to the smaller frond shown by us (Fig.3) and this is by no means typical of the earlier sterile leaves (Figs.7 & 8) or of the subsequent mature fertile ones (Figs.4 & 5).

We must now consider the question of the mid-rib to which Kümmerle attached such importance. When fronds of some 2cm were examined on cultured plants of *Biropteris* they did indeed show the type of venation described and illustrated by Kümmerle, i.e. two basal lateral veins and a central dichotomizing axis. Subsequent leaves on this same plant showed an increasingly more distinct mid-rib until the fully mature and fertile fronds were indistinguishable in this respect from a normal plant of *A. scolopendrium.* Kümmerle's dichotomizing venation is thus only typical of primordial leaves. The other point in this connection, i.e. the cross sectional appearance of the petiole, is a character which has been shown to be unreliable in certain other members of the Aspleniaceae and must in any case be extremely difficult to determine accurately on dried fronds only 2cm in length!

The only really convincing feature of Kümmerle's new genus was the single, linear, marginal, extrorsely dehiscing indusium which, as mentioned above, did not agree with either *Asplenium* or *Phyllitis.* However, if we again assume that Kümmerle's material was extremely young and we examine the very first fertile fronds of other *Biropteris* material, it is not at all uncommon to find single, linear sori. Kümmerle's illustration clearly shows a single undulate sorus on the upper margin of an indentation in the lamina edge. This is identical to the behaviour of our own very young material but this subsequently developed to give fronds with characteristic paired sori extending to the indented margins.

In view of these observations there is no reason to doubt that the material described by Kümmerle and that collected subsequently by Rechinger and Greuter from Psiloritis and by ourselves from Lefka Ori is of the same taxon. Since none of Kümmerle's four generic characters remain constant as plants develop it is clearly unjustifiable to maintain *Biropteris* as a separate genus, but its correct taxonomic position is very difficult to assess. It has in the past been assigned to *A. sagittatum* (DC.) A.J. Bange (RECHINGER 1945; VALENTINE 1964). However, as remarked above, almost all the plants examined by us show the cordate base of the frond characteristic of *A. scolopendrium* and completely lack the auricles typical of *A. sagittatum.* The only other difference noted by VALENTINE (1964) between these two species is in the sori which tend to be shorter and wider in the latter case, but observations of cultured material of all three taxa suggest that this is an unreliable character. On the basis of the only good distinguishing morphological character, namely the auricles, *Biropteris* seems to be closer to *A. scolopendrium* than to *A. sagittatum.*

This is also borne out ecologically since *A. sagittatum* is a plant of moist and shady situations near the Mediterranean coast. The known localities for *Biropteris antri-jovis* are, however, in very dry environments at 1200m or above with some as high as 1800m. We are therefore of the opinion that *B. antri-jovis* is more closely allied to *A. scolopendrium* than to *A. sagittatum.*

It is perhaps relevant to mention here aberrant forms of *A. scolopendrium* with similar frond characteristics that have been found in nature (See LOWE 1891: 96–98) or that have resulted from horticultural sowings (e.g. *A. scolopendrium* 'Laceratum': KAYE 1968; col. tab. facing p.24). One such plant (Fig.6) collected by Lovis and Vida from the wall of Leven's Park, Westmorland, has been in cultivation at Leeds since 1967. The fronds were initially similar, although larger, to those collected by Greuter on Psiloritis, the margins lobed and the sori marginal, but this state has been only partially maintained in culture. Many forms, such as 'Laceratum' mentioned above, breed true from spores suggesting there is a latent assemblage of genes which from time to time express themselves throughout the range of the species. *B. antri-jovis* could be the result of such a form having arisen in this way on Crete and having established itself in the somewhat extreme habitats of the mountains of that island at the expense of the more typical *A. scolopendrium* which may be, for some reason, less well adapted to this rigorous environment. Possibly there is now no typical *A. scolopendrium* left on the island (certainly none of the collections examined by us have been unequivocal) but extension of the range of *B. antri-jovis* outside the island may have been precluded by the distances involved. The fact that we regard forms of *A. scolopendrium* as cultivars in this country is not at variance with the taxonomic treatment suggested here in view of their totally different status in the flora.

One further character was investigated, namely the ornamentation of the sporoderm. Spores from *A. scolopendrium* from the Isle of Mull, Argyll, Scotland, (Pl. XXVIIIA) were seen to have a dense array of spiny cusps and toothed ridges which are often vacuolate. The same species from southern Greece showed a similar pattern. Typical *A. scolopendrium* from Central France (XXVIIIB), however, showed fewer cusps, the ridges being smoother, thicker and becoming retiform.

In spores of *Biropteris* from Crete (Pl.XXVIIIC) the sporoderm was finely and retiformly ridged or folded and vacuolate so that some ridges appeared as a series of arches; cusps on the ridges were few. In *A. sagittatum* (Pl.XXVIIID) the sporoderm was similar to *Biropteris*, the ridges were fewer, more massive but still vacuolate. The photographs show typical examples; there is considerable variation even on one frond but, on the whole, *A. sagittatum* from various localities throughout the Mediterranean was distinct from *A. scolopendrium*, while *Biropteris* was, if anything, more akin to *A. sagittatum* rather than *A. scolopendrium.* The almost intermediate spore from France suggests a wider spore survey would be worthwhile. However, spore morphology does add weight to the separation of *antri-jovis* as a distinct subspecies.

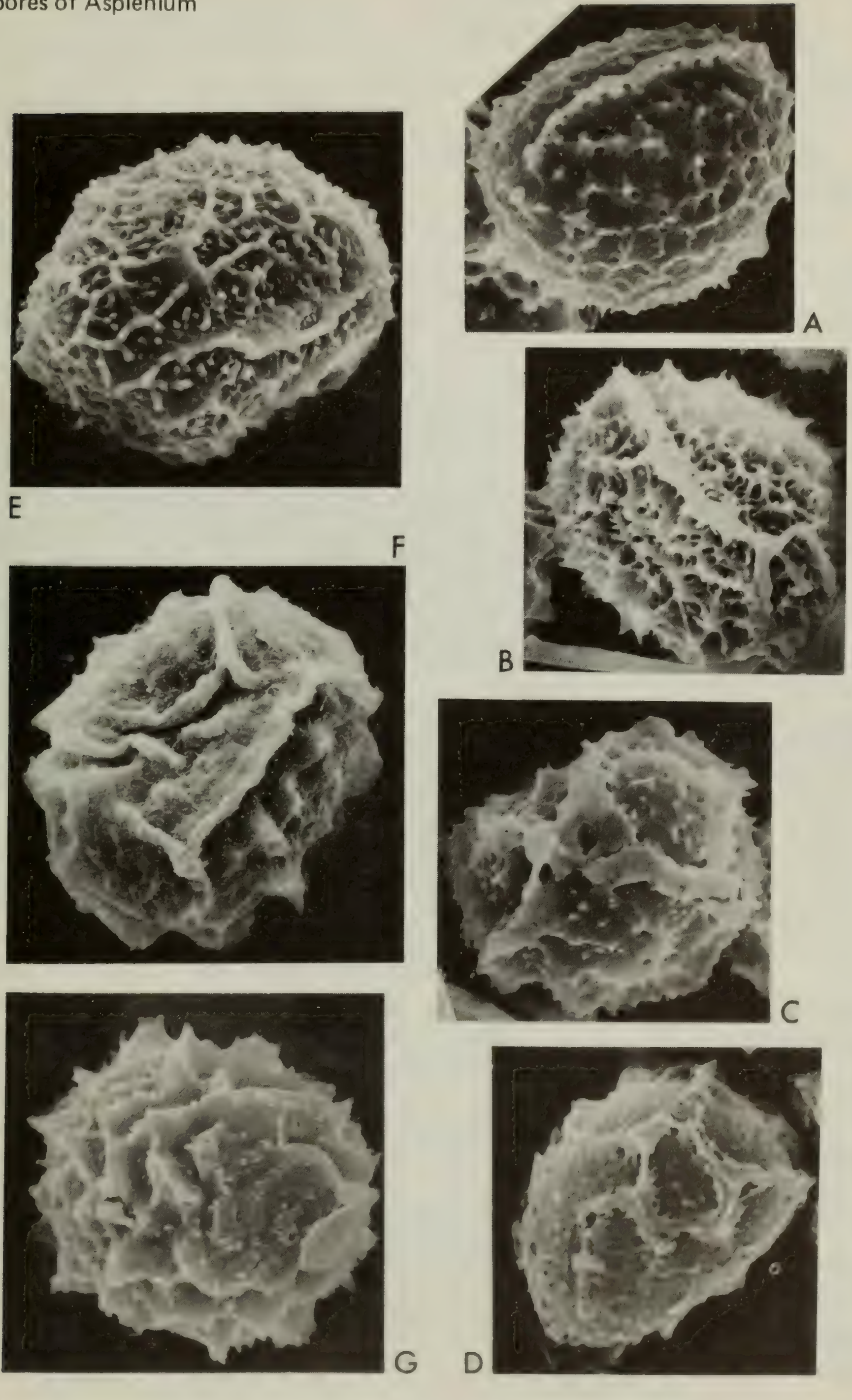
The situation might have remained at this slightly unsatisfactory stage had it not been for some extremely interesting results from Gabor VIDA (1972 and pers. comm.). He showed that material of *Biropteris* collected from Psiloritis formed fully fertile artificial hybrids with *A. scolopendrium* which 'gave rise to complicated F_2 progeny with every intermediate between the two parents'. These results are thus positive evidence of an affinity between *Biropteris* and *A. scolopendrium.* However we must point out that EMMOTT (1963) produced artificial hybrids between *A. sagittatum* and *A. scolopendrium* which showed some degree of genetic affinity (up to 9 bivalents at meiosis out of a possible 36) and suggested that they had only partially diverged from a common ancestor. It is not impossible therefore that *B. antri-jovis* is a third 'species' and that it would also give fully fertile hybrids with *A. sagittatum.*

Finally one collection by Zaffran from the Dikti Ori cultured by Reichstein since 1965 has the indented margin and marginal sori typical of *Biropteris* but it also

PLATE XXVIII. Spores of *Asplenium,* X 1000. **A**: *A. scolopendrium,* Isle of Mull, Scotland, BMMS 3049. **B**: *ibid.* Massif Central, France, Callé 334. **C**: *A. scolopendrium* subsp. *antri-jovis,* Crete J9194. **D**: *A. sagittatum* Baleares, L.F. Ferguson 2213. **E**: *A. haussknechtii,* Crete, J8962. **F**: *A. ruta-muraria* subsp. *dolomiticum,* type JDL 1963 87T. **G**: *ibid.* subsp. *ruta-muraria,* Crete, J9329.

PLATE XXVIII

Spores of Asplenium



has auricles at the base of the lamina. We do not believe that this solitary collection invalidates our conclusion, based on numerous other collections and cultures of *B. antri-jovis* without these auricles, that the taxon is most closely related to *A. scolopendrium* any more than the cultivar 'Sagittato-cristatum' (which also has pronounced auricles) violates the concept of *A. scolopendrium* in this country. However, it does impress upon us the fact that cultivation of more material brought in from the wild will be necessary to ascertain the nature and distribution of this complex on Crete and that a great deal more hybridization work is essential to a full understanding of this problem.

Meanwhile it is obvious that *Biropteris* can no longer be maintained as a separate genus and that the material assigned to *B. antri-jovis* is, on present evidence, most closely related genetically and morphologically to *A. scolopendrium.* In view of these observations we propose a new combination for this taxon namely **Asplenium scolopendrium** subsp. **antri-jovis** (Kümm.) Brownsey & Jermy **comb. nov.** (bas.: *Biropteris antri-jovis* Kümmerle, Magyar Botan. Lapok. 1920: 3; 1922).

Cystopteris fragilis s.l. Gatherings of this complex were made on all three main mountain massifs. All have spiny spores but show a denser array than others and the perispore patterns agree well with known tetraploid and hexaploid plants (Vida and Reichstein pers. comm. & JERMY & HARPER 1971). At least three specimens (J 9094, 9193:1, 9223) show abortive spores and may well prove to be pentaploid (cf. VIDA 1972). Many specimens have the broad lamina segments characteristic of *C. dickieana* Sim but no granulo-rugose spore types were seen. One gathering (J 9173) from the north face of Hagios Pnevma, which has remained constant in cultivation, has very divided fronds but is not *C. regia* (L.) Desv. Further work is being undertaken on this group (Jermy & Vida in prep.).

Dryopteris villarii/pallida complex. This occurs throughout Crete from the lowland *Castanea/Platanus* woods to shady gullies (or sometimes full sun) up to 1400m. The species prefers the alkali clays or limestone rocks and in some river valleys may be the commonest fern. On the whole the frond structure is uniform and can be referred to *D. pallida* (Bory) Fomin, a diploid cytotype only subtly different from our British tetraploid *D. villarii* (Bell.) Woynar. On occasions the degree of pinna cutting was such as to give the superficial impression of *D. filix-mas*; earlier records for this species from Crete (which have never been authenticated) may well have been based on *D. pallida.*

FERNS DEFINITELY RECORDED FOR CRETE

Selaginella denticulata (L.) Link
Isoetes histrix Bory
Equisetum ramosissimum Desf.
E. arvense L.
E. telmateia Ehrh.
Ophioglossum lusitanicum L.
Osmunda regalis L.
Cheilanthes pteridioides (Reichard) C.Chr.
C. vellea (Ait.) F. Muell.
C. persica (Bory) Mett. ex Kuhn
Adiantum capillus-veneris L.
Asplenium obovatum Viv.
A. onopteris L.
A. ruta-muraria L. subsp. ruta-muraria
A. lepidum C. Presl
A. haussknechtii Godet & Reuter
A. creticum Lovis et al.
A. aegaeum Lovis & Reichstein
A. ceterach L.
A. scolopendrium L. subsp. antri-jovis (Kümm.) Brownsey & Jermy

Pteris vittata L.

Anogramma leptophylla (L.) Link

Pteridium aquilinum (L.) Kuhn subsp. aquilinum

P. aquilinum subsp. brevipes (Tausch) Wulf

Christella dentata (Forssk.) Brownsey & Jermy

Asplenium trichomanes L. subsp. quadrivalens D.E. Meyer

A. trichomanes subsp. inexpectans Lovis

A. viride Hudson

Athyrium filix-femina (L.) Roth

Cystopteris fragilis (L.) Bernh.

Polystichum lonchitis (L.) Roth

P. setiferum (Forssk.) Moore ex Woynar

Dryopteris pallida (Bory) Fomin

Blechnum spicant (L.) Roth

Woodwardia radicans (L.) Sm.

Polypodium australe Fée

P. vulgare L.

ACKNOWLEDGEMENTS

We should like to thank in particular Mr and Mrs Goulandris and Mrs M. De Mott and the staff of the Goulandris Natural History Museum, Kifissia for their hospitality and help with administrative matters. In particular they put us in contact with their collector John Petamidis in Iraklion who was our constant companion in the field and whose help in arranging guides and accommodation was invaluable. Our thanks must also go to his family for their hospitality and to Mr A. Kornos of Iraklion and the President of the Alpine Club of Greece (Khania Branch) for permission to use the chalet at Volikas. Mr J. Zaffran and Dr W. Greuter also gave much useful information in the planning stage of the expedition.

Thanks are also due to Dr Gabor Vida for permission to quote his unpublished results and to Prof. T. Reichstein and Dr J.D. Lovis for giving us samples of their living collections for study and for access to their unpublished paper.

One of us (P.J.B.) would like to thank the Science Research Council (UK) and the Godman Expedition Trust for financial assistance towards travel and field expenses.

The electron micrographs were taken at the British Museum (Nat. Hist.) on a Cambridge Mk II Stereoscan and we thank Mrs Joyce Holman for technical help in this respect.

Research material is being grown at Chelsea Physic Garden and at Leeds University Botanical Garden and we thank John Caskey, Peter Lee, Frank Horwood and Albert Henderson for their care in maintaining these cultures.

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REVIEW

ATLAS FLORAE EUROPAEAE, Distribution of vascular plants in Europe. Vol. 1. Pteridophyta (Psilotaceae to Azollaceae). Edited by Kaakko Jalas and Juha Suominen, 121 pp., 150 maps, 21.5 X 28.0 cms. The Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo, Helsinki, 1972. Distributed by Akateeminen Kirjakauppa, Keskuskatu 1, SF-00 100 Helsinki 10, Finland. Price £3.98.

There is something about maps which fascinates, and this first volume of the Flora Europaea Atlas is no exception. This series is, to Flora Europaea, approximately what the Atlas of the British Flora is to Clapham, Tutin, and Warburg's Flora of the British Isles. Volume 1 conveniently encompasses the whole of the Pteridophyta [in the order Psilopsida, Lycopsida, Sphenopsida, and Filicopsida.] One hundred and fifty maps are given, showing the European range of the ferns and their allies, with normally one map per species.

Geographically, the Atlas covers the whole of the Flora Europaea area from Iceland and the Faeroes, Jan Mayen, Spitzbergen (inset), and mainland Europe as far as the Urals and Caspian Sea, to the north coast of the Mediterranean and its islands from Crete westwards to the Azores (inset). The final scale of the base maps presented is 1: 31,000,000 (most maps are about 14.5 X 17 cm) and a mapping unit of a 50 km square has been used (c f. a 10 km square in the Atlas of the British Flora). The choice of map projection used (Universal Transverse Mercator) appears at first sight to lead to some anomalies (the symbol rows diverge from north to south with consequent occasional compensation in the number of rows present), but the advantage of a map projection rendering areas in their correct proportions and positions seems a wise choice, and greatly outweighs any minor disadvantages of the system.

Although solid dots are used for the native occurrence of each plant per square, other symbols are used, where appropriate, for effectively-naturalised aliens, plants of uncertain status, old or extinct records, etc., providing a helpful reminder of the local status of each plant, and areas that should be further checked. When consulting the maps, the under-recording of most species in the whole of the east European area should be borne in mind (e.g. the maps of such ubiquitous European taxa as *Equisetum palustre, E. fluviatile, E. sylvaticum, Pteridium aquilinum, Athyrium filix-femina,* and *Dryopteris filix-mas*). Any stimulation brought about to fill some of these gaps would alone be a worthwhile achievement of the *Atlas.*

Textual comments along with each map give names of species and authors and important synonyms. Special notes and references to taxonomy, nomenclature, and important new or omitted records or a special problem are included where they complete or correct Flora Europaea. Some information on total ranges is given, usually in the form of references to other works. These are helpful. In a work of this magnitude, small omissions and errors are bound to be included at first. For instance, the textual comments under *Cheilanthes vellea* "Islas Canarias" could have been included in the distribution of the diploid cytotype, although it is listed (correctly) in the range of the tetraploid. Under *Elaphoglossum paleaceum,* the Hooker and Greville synonym might have read better as *"Acrostichum paleaceum".*

Flora Europaea has usually been followed for the delimitation of species (and sub-species as appropriate), and any changes are expressly mentioned. *Phyllitis* and *Ceterach* are still treated as separate genera from *Asplenium* (although all have a chromosome base number of n=36 and may hybridise), and *Notholaena* (with all European taxa based on n=29) remains sunk into *Cheilanthes* (with all European species based on n=30). The authors have, however, shown a commendable willingness to accept cytological data at species and infra-specific level, and effort has been taken to distinguish cytotypes on the maps where sufficient information is available. This is particularly notable amongst some of the members of *Cheilanthes* and *Asplenium* and in the maps of *Dryopteris villarii* (2n and both 4n forms are distinguished), *Ceterach officinarum* (2n and 4n subspecies are mapped separately), and the *Polypodium vulgare* aggregate (separate maps for the 2n and 6n species, although the 4n plants are not separated from the collective species). It is, however, surprising to find only one map for *Asplenium trichomanes* sensu lato.

Many pteridologists will probably also regret that it has not been possible to include in the Atlas maps of any of the more frequent hybrid taxa now known (some widespread) in Europe — a critical supplement, however, could rectify this situation. A further suggestion is that the value of certain maps might be increased by including their total range where this occurs in the *extra*-european areas which already appear in outline on the maps. A few dots on the North African coast, for example, would do this for *Asplenium hemionitis, Davallia canariensis,* and *Phyllitis sagittata.*

Overall, the maps present a pleasing and readily-assimilated picture of the known European range of each of the plants. There is, however, as yet no generic and specific index, although an index to the pages on which each family begins is given. The amateur pteridologist might consequently find some difficulty at first in quickly locating genera whose families may not be immediately familiar to him. A running heading of families on the top right hand corner of each page might also have helped when thumbing through, as the book is, primarily, a work of reference. Both as a record of current knowledge on pteridophyte distribution and as a stimulant for further recording and research, however, this book seems destined to become a classic amongst pteridological literature. The compilers and editors are certainly to be congratulated.

C.N. PAGE

The Phylogeny and Classification of the Ferns

Edited by A. C. Jermy, J. A. Crabbe and B. A. Thomas

September 1973, approx., 400 pp., approx., £7.20
0.12.385050.9

This book will be published in the autumn by Academic Press. For a leaflet giving details of the contents, please write to the publishers. A special price will be offered to members of the British Pteridological Society. Further information will follow when a firm price is fixed.

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The British Fern Gazette Volume 10 Part 5 was published on 21 March 1973.

Printed by Econoprint Ltd., Edinburgh.

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